slabs are reinforced transversely for both negative and positive moments, while the stringers are reinforced longitudinally for positive moments only. At the abutments all stringers are furnished with cast-steel shoes and bedplates, and provisions are made for temperature distortions, as shown in the detail in Fig. 2.

The principal structural elements of each of the three 31-ft. 6-in. deck-span units at Arsenal St. consist of 10 lines of stringers and a 10-in. slab. The top line of a transverse section of the slab is straight at a depth of 12 in. below the street grade. This 12-in. clearance allows track construction with 7-in. rails and 4-in. special steel crossties. It also necessitates the use of considerable filler concrete over the slab for the bases of pavements and walks. The stringers are 24 and 30 in. wide, 22 in. deep below the bottom of the 10-in. slab and, save the four under the tracks, are at 6 ft. 4 in. centers.

The longitudinal reinforcement of the stringers consists of rods placed in one layer with approximately one-half the number of these rods bent up near the stringer ends and anchored within the compression area of the concrete section. Throughout, the stringers are further reinforced by vertical stirrups which circumscribe the longitudinal bars and, by hooked ends, engage the top system of transverse rods in the slab.

In the design of these bridges the anticipated settlement of the soil-bearing abutments was a cardinal factor for the adoption of a type of construction which provided "clean-cut" full-width construction joints in the deck structure over the center line of each pier beam—a type in which longitudinally, simple beam action might truly prevail.

Both bridges were designed for the following surface loadings: (a) An 18-ton road roller on roadway stringers; (b) a 16-ton concentrated wheel load on roadway slabs; (c) a uniform roadway load of 125 lb. per sq.ft.; (d) a uniform sidewalk load of 100 lb. per sq.ft.; and (e) for the Arsenal St. bridge only, a 50-ton street-railway cinder car on track stringers.

Critical combinations of these loads augmented by an arbitrary impact allowance of 30%, together with the dead weights, generate figured maximum unit stresses in various elements of the structures not exceeding the following pounds per square inch: (a) Axial compression in concrete, 450; (b) flexural compression in concrete, 650; (c) shear in concrete, 120; (d) tension in steel, 16,000; (e) bond in plain bars, 50; (f) bond in deformed bars, 120.

Quantities and Prices

For purposes of comparison the following details of quantities and prices are given:

	Arsenal St.	Columbia Ave.	
Span lengths	31 ft. 6 in.	32 ft. 0 in.	33 ft. 6 in.
Overall depth	3 ft. 8 in.	3 ft. 2 in.	3 ft. 2 in.
Quantities per sq.ft.:			
Concrete, structural, cu.ft.	2.00	1.65	1.65
Reinforcement in slabs, lb.	4.10	3.80	3.80
Reinforcement in longitudinal stringers, lb.	7.50	5.40	5.70
Reinforcement in stirrups, lb.	2.55	1.80	2.00

The average dead-weight of deck structure complete with pavements, etc., is 270 lb. per sq.ft. at Columbia Ave. and 400 lb. at Arsenal St. This increased weight at Arsenal St. resulted largely from the filling required under the pavements and considered together with the street-car loading makes manifest the necessity of increased structural quantities over those required for the somewhat longer deck units at Columbia Ave.

	Quantities		Unit
	Arsenal St.	Columbia Ave.	Price
Earth excavation	6,300 cu.ft.	9,900 cu.ft.	$0.06
Rock excavation	110 cu.ft.	20 cu.ft.	.30
Concrete, Class A	6,160 cu.ft.	11,070 cu.ft.	.33
Concrete, Class B	11,560 cu.ft.	10,250 cu.ft.	.35
Concrete, Class C	360 cu.ft.	500 cu.ft.	.90
Steel reinforcement	103,300 lb.	85,000 lb.	.025
Steel castings	3,860 lb.	2,180 lb.	.07

This makes a cost of $9,700 for work done under contract at Arsenal St., and $10,600 at Columbia Ave. To these figures must be added items of $1,800 for costs of labor and material expended by the city in removing the old bridge and its abutments and the construction of pavements, curbs and walks at Arsenal St., and $1,100 at Columbia Ave. for the construction of embankments and roadway pavement. These items, together with others for plans, inspection, etc., make the total cost of each of the two finished bridges approximately $12,400.

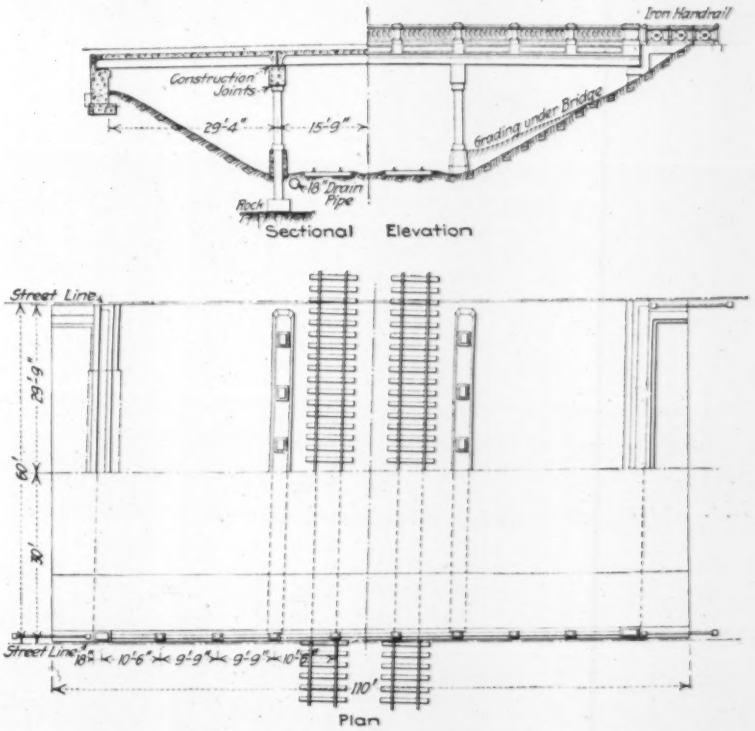


FIG. 3. OUTLINE OF ARSENAL ST. BRIDGE AT ST. LOUIS

Formwork Notably Simple

Primarily on account of the limited clearance over the steam-railway tracks, 10-in. 25-lb. steel I-beams were used for the principal longitudinal members of the falsework spans. At the bridge ends they rested directly upon the abutments and at the pier bents were supported by 6x12-in. timbers capping 6x8-in. posts which acted also as studding for the side sheathing of the pier-beam forms. At midspan points additional support was provided by

framed bents. Throughout, the I-beams were placed in the bays between the concrete stringers and straddled by inverted ⅝-in. U-bolts that carried a transverse system of underhung 3x6-in. joists on which the form sheathing was framed. This arrangement of forms provided a vertical clearance over the railway tracks of 17 ft. 3 in., which is only 9 in. less than that of the finished bridges.

General Conclusions to Design

These bridges are of fairly good appearance and in general of satisfactory detail. The columns and the arrangement of end bearings for stringers at the abutments are two structural features offering marked chance for betterment in future bridges of this type. While the sectional dimensions of the columns are such as to provide adequate axial strength, improved architectural appearance as well as augmented resistance to sidewise impact would have resulted from their enlargement. Though frequent inspection of stringer ends has thus far revealed no evidence of inadequacy in the used arrangement of end shoes and bearing plates, it now appears to the writer that somewhat improved detail might have been obtained by placing the shoes farther forward along the bottom of the stringers so as to secure more positive anchorage for them. Or probably still better, these cast-steel bearings might have been omitted and the stringers anchored directly into some type of flexible abutment.

Both bridges were built under the direction of the Bridge Division of the Street Department of the city, under C. M. Talbert, Street Commissioner; L. R. Bowen is Bridge Engineer. The writer designed the structures and was in charge of their construction for the city.

Rail Joints on Philadelphia & Reading Railway

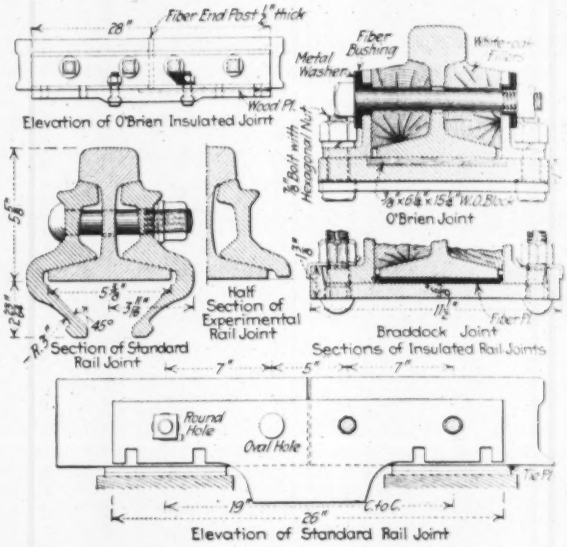
The standard splice adopted by the Philadelphia & Reading Ry. in 1915 for its 100-lb. rails consists of short splice bars of a heavily ribbed section, with four bolts, as shown in the accompanying drawing. The bars are 26 in. long and are of the "100%" pattern, in which the middle part has an inclined flange extending inward beneath the rail, as shown. This construction is for the purpose of increasing the stiffness of the joint at the middle. The splice bars are slotted for the track spikes and have the bolt holes spaced 5 in. for the inner and 7 in. for the outer bolts.

The bolts are 1 in. in diameter, with oval necks, and the heads are shaped to fit the ribs of the splice bars. Spring nutlocks and heavy square nuts are used, the nuts being 1 in. thick for ordinary bolts and 1⅛ in. for those of heat-treated steel. The bolts are placed with heads alternately on the inner and outer sides of the joint, as is now very general practice. The bolt holes in the splice bars are alternately 1 1/16 in. in diameter and 1 1/16 x 1 5/16 in. oval, while the holes in the rails are 1 3/16 in. in diameter.

The railway is experimenting also with a joint that has no part extending beneath the rail, as shown in the drawing. This arrangement will permit renewal of rails without any disturbance of ballast or adjustment of the positions of the ties to fit the joints. Except for the section of the splice bars this joint is similar to the standard joint just described.

For insulated rail joints two standard designs were adopted in 1915—the O'Brien and the Braddock joints. The former, which is the more generally used, is shown on the drawing. It consists of a heavy base plate, 25 lbs. to the yd., recessed at one end to receive a ⅜-in. white-oak bearing plate for one rail. Angle splices are bolted to the sides of the base plate, and between them and the webs of the rails are white-oak fillers. Slotted holes in the horizontal legs of the angles permit lateral movement in tightening up the splice bolts.

The long splice bolts are fitted with fiber bushings where they pass through the splice angles. The joints have four or six bolts (all with 28-in. splice bars), the spacing being 5¼ and 7 in. for the former and 4¼, 4 and 5 in. for the latter. The rail ends are separated



RAIL JOINTS ON THE PHILADELPHIA & READING RY.

by a ½-in. fiber end-post shaped to conform to the rail section.

The Braddock joint is very similar in design, but has a base plate of channel section, with ribs outside the splice angles. Each angle is held by a single vertical bolt. The base has no pocket for a bearing plate, but a steel shim is placed beneath one rail and a fiber shim beneath the other, each of these being 3/16 in. thick.

For drawings of these joints we are indebted to Samuel T. Wagner, Chief Engineer, Philadelphia & Reading Ry.

A Great Irrigation System in India was opened officially in December. It comprises three separate but connected canals—the Upper Jhelum, the Upper Chenab and the Lower Bari Doab. These aggregate 322 mi. in length, with about 22,645 mi. of auxiliary channels and laterals. They provide for the irrigation of about 2,200,000 acres of arid land in the Punjab province, in the northern portion of the country. As described in a paper presented before the Institution of Civil Engineers by Sir John Benton, the eastern portion of the Punjab had a tract of 1,500,000 acres of arid but good land which could not be irrigated from any water-supply near at hand, owing to previous utilization and reservation of such supply. On the western side of the province the Jhelum River provided a large and unused amount of water. To deliver it to the arid lands necessitated extensive and difficult works, with the crossing of two large rivers and numerous mountain streams and torrents. Bridges are spaced at average intervals of 1.6, 1.5 and 3.4 mi. for the three canals respectively. The regulating works, etc., are largely of brick. Chambers in the floors provide settling basins for the silt and so reduce erosion of the masonry floor. Inspectors' houses are placed at intervals of about 10 mi. There is a complete telegraph system. Flour mills have been located at some of the falls on the canals. The project has been carried out by the provincial government of the Punjab at a cost of about $35,000,000.

Four Years of Concrete Roads in One County

The differences in construction and service results of the concrete roads in Lake County, Ohio, were detailed in an excellent paper read at the annual meeting of the Ohio Engineering Society on Feb. 10 by H. P. Cumings, County Surveyor of Lake County. Extracts from the paper follow:

The first concrete road in Lake County was built in 1912 under state specifications and state supervision, on the road leading south from the village of Madison; its length is 1.41 mi.; width, 12 ft.; thickness of concrete, 6 in.; cross-slope, 2 in. The soil is a heavy clay. It was a one-course job, and the mix specified was 1 : 1½ : 3½. The surface was finished with a wood float; and after the entire length of pavement was completed, it was cleaned as thoroughly as possible and given a surface treatment of tar.

The cleaning process was no joke, as the pavement had been covered with clay to aid in curing, and a considerable part of it had been traveled over for several weeks. Steel brooms, reed brooms and barn brooms were used, and we hoped that what clay didn't come off would be absorbed. Perhaps this was the case, for over the greater part of this pavement the tar stuck well.

Over a stretch of several hundred feet in one location it peeled off badly the first winter, without any reason that I was able to discover. This section was repaired the following spring and has since stood as well as the other part. A half-dozen cracks have appeared. This pavement has convinced me that concrete can be laid on a clay soil and not break up from the effects of freezing and thawing.

The contract price of this pavement was $11,970. The contractor assures me, however, that those figures do not indicate what the pavement actually cost.

Dead Rock Caused Holes in Second Pavement

The second concrete pavement was laid in Lake County in the summer of 1913. It is 2.21 mi. in length, 12 ft. in width and 6 in. thick. It was built under state specifications and is a two-course job, the cost being about $25,000. The soil is clay. The foundation course consists of a 1 : 2½ : 5 concrete 4 in. deep; the top course is of a 1 : 1½ : 3 concrete 2 in. in depth.

Local creek gravel was used as the coarse aggregate for the base; the fine aggregate was a creek sand from the same location as the gravel and showed up exceptionally well in tests. The coarse aggregate for the top was obtained by crushing boulders collected from the near-by fields. A large percentage of these boulders was granite and supplied a crushed rock of very good quality. There were, however, among them some of a soft, or dead, quality. This accounts for the fact that numerous holes have appeared in the surface of certain parts of this pavement.

Before the concrete was opened to traffic, the surface was thoroughly broomed with steel brushes, and a coating of tar and granite screenings applied. When the supply of screenings from the crusher plant was exhausted, the remainder of the surface was covered with fine silica gravel. The screenings seemed to give the more satisfactory surface. The tar coating, however, began peeling off badly the first season after being completed, and today about one-half the surface is bare. This pavement has had a considerable amount of heavy traffic.

Three blocks have broken badly, owing to settlement of a fill. Considerable cracking has occurred, about 100 blocks being broken out of a total of 390. Some displacement has taken place at joints, due, I think, chiefly to settlement of blocks.

In the summer of 1914 an extension of this pavement was built. This extension was 1.34 mi. in length and was similar in every way to the one just described, except that the top course was a 1 : 1 : 2 concrete; slag was used for the coarse aggregate in the base, silica gravel in the top for about one-half the job and hard limestone in the top for the remainder. No tar was used.

The surface is today in almost perfect condition, but a considerable amount of cracking has taken place, about 100 blocks being broken. A very close examination is required to detect the difference in the surface where the silica gravel was used and where the limestone was used. The contract price of this work was $17,115. In both the two last described pavements the cracks are about equally divided between longitudinal cracks and transverse cracks, but in each case nearly all occur in the middle one-third of the block.

Experience with Pebble Wearing Surface and Poor Sand

Also in the summer of 1914, in the township of Madison, 9.8 mi. of county road were built under two contracts—one for the South Ridge Road, the other for the Lake River Road. The South Ridge road pavement is 16 ft. wide, 6 in. thick at the edges and 7 in. in the center, the surface having a crown of 1½ in.; it has one course—1 : 2 : 3½.

The fine aggregate was a dredged lake sand. Our only difficulty in keeping this sand up to requirements was to get sand that was sufficiently coarse, and it was necessary to reject a number of carloads on this score. The coarse aggregate was the very hard, round, smooth pebble that we know as silica gravel. The condition of this pavement at the present time would indicate that a concrete built with this pebble offers a wearing surface almost indestructible under the abrasive wear of ordinary traffic, but also gives a body lacking in tensile strength.

Reinforcement Prevents Cracking

Some 90 blocks were reinforced with American Steel and Wire Co.'s triangle mesh No. 28. These blocks were in wet or springy places, on fills or where sewer trenches had been excavated. Out of these 90 blocks (33⅓ ft. each) about a half-dozen have fine cracks. These have not opened up so as to cause any damage whatever. You can follow a longitudinal crack down the center of this pavement block after block, till it comes to a block that was reinforced because of a sewer trench. This block will be perfectly sound, and the crack will begin again on the other side. A few transverse cracks have appeared, but the most of the cracks are longitudinal. These cracks nearly all appear in the middle one-third of the block.

The first half-mile of this pavement was laid with ⅜-in. expansion strips at the joints, with no armor plates. The edges of the blocks at these joints have rounded off, but the raveling has increased very little since the first few months of traffic. After the first half-mile was laid, all joints were armored with Kahn plates. These joints

are in practically perfect condition, except where the concrete was left too high and floated over the plates, in which cases the edges of the blocks have rounded down to the plates.

The cost of this road was $97,909.37, divided into four general groups as follows: Grading, $11,465.50; drainage, $13,082.17; pavement, $71,738.26; masonry and culvert repairs, $1,623.44.

On the Lake River road the same difficulties in securing a sufficiently coarse sand were experienced in the early shipments for this road as on the South Ridge road. Some of this defective sand got into the first mile. As soon as the last block laid was three weeks old, hauling over it of material for the 2½ mi. north of it was begun. At numerous places in this mile of pavement the surface has worn down under traffic, showing depressions at these spots of from ½ to 1 in. Most of this wear seems to have occurred during the first few months after the pavement was opened to traffic, very little additional wear having occurred at these places during the past summer.

We believe some of these defects are due to poor sand, but a greater cause is the breaking of the bond in the surface of the concrete by too heavy traffic before the concrete was old enough to withstand this weight. I have observed that a traction engine with lugs on the wheels, which would chip the pavement in passing over it the first season after it was opened to traffic, will now pass over it without leaving a mark, showing conclusively that the pavement is not at its best for a long time after it is laid and that traffic should be kept off it as long as a long-suffering public can be made to suffer.

The cost of this road was $72,841.07, divided into the four groups as follows: Grading, $5,992.04; drainage, $10,344.45; pavement, $56,430.58; masonry, $64.

New Pavement Reinforced; Crushed-Rock Aggregate Used

Our experience with the Madison pavements, not only in the matter of the cracking of the concrete, but also because of difficulties we experienced in securing a uniform grade of gravel for a coarse aggregate, determined us to use only a crushed rock for the coarse aggregate in the next concrete pavement to be built in Lake County, and also determined us to reinforce all future concrete pavements. Following out this decision, contracts were let in the spring of 1915 for paving with concrete three roads in the township of Perry, aggregating 9.73 mi.

The concrete pavement is 16 ft. wide, 6 in. thick at the edges and 7½ in. in the center. The concrete was laid in two courses, the base being 4 in. at the edges and 5 in. at the center; the top course is 2 in. at the edges and 2½ in. at the center.

These pavements are now going through their first winter. It is too early to be able to say what they will eventually show. They have already passed through four periods of moderate freezing—one period reaching zero—followed each time by a sudden thaw and complete break-up. Up to the present time I have not been able to discover one crack or defect of any kind in the entire 7.5 mi., though I have made several careful inspection trips over them; nor have any been reported.

Out of six roads herein described, each somewhat different in its construction from the other, we have pinned our faith to the Perry construction.

Diagram Giving Excess Loss of Head in 90° Bends

By Frank S. Bailey*

Losses of head owing to bends in pipe are of so much importance in complicated systems of piping, such as fire-sprinkling systems, sewage-sprinkling filter systems, piping in pumping stations, automatic dosing tanks and the like, that it is hoped and believed the accompanying diagram will prove of much assistance to engineers requiring such information. This hope and belief are increased by the fact that the writer has not seen any other diagram or table in which excess loss of head due to bends on account of varying velocities of water in pipes can be found so rapidly as by means of this diagram.

The diagram was prepared by the writer for use in the office of Metcalf & Eddy, and is published with their permission. It is based on the formula proposed by W. E. Fuller, of Hazen, Whipple & Fuller, in a paper by him which appeared in the *Journal* of the New England Water-Works Association, for December, 1913.

Mr. Fuller says, in effect, that the experimental data are insufficient to settle some of the questions involved in the loss of head in bends, and that further experiments may show the desirability of modifying the formula. This formula, however, agrees fairly well with most of the experiments made recently, and in the opinion of the writer is without doubt the best one which has thus far been suggested. In deriving it, the experiments of Williams, Hubbell and Fenkell, at Detroit, of Schoder, at Cornell, Davis, at the University of Wisconsin, Brightmore, in England, and others were considered.

The formula is $H_B = KV^{2.25}$, in which

H_B = Loss of head in feet in a 90° bend in excess of the loss in a straight pipe of length equal to the length of the curve at the center of the pipe;

K = A coefficient, different for bends of different radii;

V = Velocity of water in ft. per sec.

In the diagram here presented the value of H_B is not given, but instead the loss of head in feet due to a 90° bend in excess of the loss in straight pipe equal in length to the tangents of the curve at the center is shown. In practice it is better to know this loss, as, to quote Mr. Fuller, "It is most convenient to compute the loss of head in pipe lines by taking the actual lengths of the tangents as straight pipe, finding the frictional resistance in it and then adding the excess resistance due to curves and other specials." The computations for the excess loss shown on the diagram were made as follows:

The loss of head caused by the bend, in excess of friction head for a length of straight pipe equal in length to the curve, was computed from formula $H_B = KV^{2.25}$, and the friction in a length of straight pipe equal to the difference between the length of the tangents and length of curve was then deducted. Frictional resistance in straight pipe was computed by the Hazen-Williams formula, with $c = 100$, this value of c representing average pipe after being in use a few years.

The diagram shows the excess loss as described for 90° bends of from 1- to 48-in. inside diameter and for velocities of from 2 to 8 ft. per sec. for 1- to 4-in. sizes, and also

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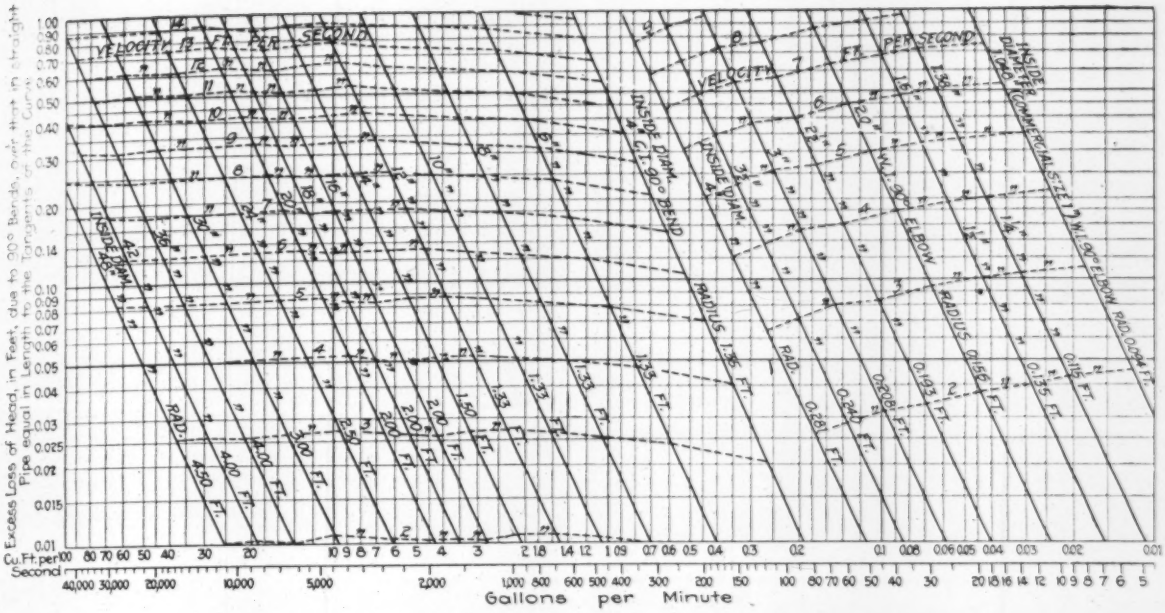

DIAGRAM GIVING EXCESS LOSS OF HEAD IN 90° BENDS IN CAST-IRON WATER PIPE
Based on formula proposed by W. E. Fuller

from 2 to 14 ft. per sec. for 4- to 48-in. sizes; it also shows the loss in cubic feet per second and in gallons per minute when different quantities are flowing through the bend.

The radii used in the computations for the various sizes are given on the diagram. For the 1- to 4-in. wrought-iron sizes they are approximately the same as found in ordinary "malleable fittings"; for the 4- to 36-in. cast-iron bends they are American Water-Works Association and New England Water-Works Association standards; for 42- and 48-in. bends they are those given in the catalogs of the United States Cast-Iron Pipe and Foundry Co.

In computing the losses in the bends of 4- to 1-in. diameter, it was assumed that the inside diameter of the bend was the same as the inside diameter of the pipe. In some small bends the diameter of the bend is larger than that of the straight pipe, and in such cases the loss of head due to the bend will be greater than if the bend and the straight pipe were of the same diameter.

In discussing E. W. Schoder's paper, "Curve Resistance in Water Pipes" (*Trans.* Am. Soc. C. E., Vol. LXII, p. 112), G. J. Davis, Jr., gives results of experiments with a bend of $2\frac{1}{16}$-in. inside diameter attached to straight pipe of the same size, and with a bend of $2\frac{3}{8}$-in. inside diameter attached to straight pipe of $2\frac{1}{16}$-in. diameter. Both bends had a radius of $1\frac{1}{2}$ in. to the center line. He found the loss of head in the bend of $2\frac{3}{8}$-in. diameter to be about 1.8 times the loss in the bend of $2\frac{1}{16}$-in. diameter. This is worth noting, as it might be supposed that the bend of larger diameter would not cause any greater loss of head.

The reading of the diagram is simple. If, for instance, it is desired to know the excess loss of head due to a 90° standard-pattern bend in a 12-in. pipe with 5 cu.ft. per sec. passing through it, all that is needed is to find the intersection of the vertical 5 c.f.p.s. line with the sloping line marked 12-in. inside diameter and then follow parallel to the horizontal lines to the excess loss of head scale, where the excess loss is found to be 0.15 ft. The dotted lines representing velocity show that in this case the velocity in the pipe is about 6.4 ft. per sec. It is interesting to note that the velocity curves are nearly horizontal and that the same velocities in the different sizes of pipes cause similar excess losses of head, the radii of course varying as shown.

It may be of value to note that for bends of 45° Mr. Fuller suggests using three-fourths the loss of head in 90° bends of the same radius; and for $22\frac{1}{2}$° bends, one-half that in 90° bends of the same radius.

Sidewalks in Steep Streets

In hilly towns the convenient arrangement of sidewalks on steep-grade streets forms a special problem. This problem was discussed at the recent annual meeting of the Minnesota Surveyors and Engineers Society by M. E. Chamberlain, of Montevideo, Minn. It is not always realized that on sidehill streets the sidewalk need not follow the street grade or be at a uniform height above the roadway. In some cases very good results have been obtained by varying the transverse slopes and making adjustments in the sidewalks, curbs and gutters. A slope of 20% from the curb to the walk is not objectionable.

For the benefit of property on the low side of the street the curb may be located nearer to the low than to the high side, thus permitting a reduction in street-grade elevation. In extreme cases the walk has been narrowed or even placed at the curb. These variations in design minimize the damage to elevated or depressed residence property. On sidehill streets, also, another problem is often the unnecessary width between curbs. A width of 24 ft. is considered ample for residence streets.

Sidewalk steps are often necessary on steep-grade streets in hilly towns. As people walk faster out of doors, the steps should be considerably wider than those in buildings; and the author advocated 15-in. treads and 6-in. risers. In one Minnesota town there is a long flight of steps with 40-in. treads. Steps with 15-in. treads, in series separated by landings, would have been better.

Lowering Broadway Tunnel in Los Angeles

By R. W. Stewart*

The most direct route from the business district of Los Angeles to large residential sections and populous suburbs lying north is through the Broadway tunnel. This tunnel was built in 1900. It is 760 ft. long. The regrading of Broadway, although it involved a cut of 38 ft. maximum depth, left a 7.5% grade ascending north to the south portal of the tunnel. From the summit at the south portal the tunnel descended northerly on a 6% grade with an unpaved roadway.

The dense automobile traffic of recent years showed a tendency to detour around the hill through congested streets, indicating necessity for improvement of the tunnel route to make it serve the purpose for which it was intended. The matter was taken in hand by the City Council, and it was decided to lower the tunnel 20 ft. at its south end and 3 ft. at its north end, thus reducing the grade in the tunnel to 3.8% and in the block south to 2.9%. Since the old tunnel had been dark and the walls were discolored by water seeping through the masonry, it was decided that, in addition to the grade change, the interior should be lined with white-enameled tile and illumination provided.

Lining with tile required that all irregularities in the interior surface be corrected. The inwardly curving footings and slight irregularities in the old tunnel would have made it a tedious and expensive undertaking to true up the masonry; and the tunnel, if thus treated, would have had a freakish appearance, one end being much higher than the other. Because of these conditions and because of the large economy in area of tile lining and the reduction in lighting expense, it was found preferable to construct a new tunnel arch under the old one rather than undertake to treat the old surface. The details of the design are well illustrated by the figures and need little comment.

The new arch has a uniform thickness of two rings of brick, and being loaded only with its own weight, it was given a compound curvature such that its neutral axis deviates but a small fraction of an inch from a common catenary.

Provision for drainage was made by placing 3 in. of broken stone behind the underpinning walls. The most convenient and economical way of doing this work was found to be by fastening 3-in. vertical wooden strips to the face of the excavation, using thin metal clips and long nails driven into the hard clay. Thin sheet iron was then placed against the wooden strips, and the crushed stone was placed behind it in advance of the concrete, the sheet iron being left in the work. The bottom of the stone backing was drained at frequent intervals by vitrified pipes, as illustrated. Iron weep pipes were also placed, as shown, to dispose of any water that might seep through the old tunnel.

The underpinning walls were constructed in sections 10 ft. in length, the specifications providing that excavation could not be commenced for any section when there was a point within 70 ft. of such section where the tunnel was not supported either by undisturbed earth or by concrete that had set 10 days.

The new brick arch was built on traveling centering. Two sets of forms were used—one 18 ft. long and one 20 ft. long. Bricklaying was commenced both at the south end of the tunnel and at the center. One crew of 5 bricklayers and 12 helpers completed one 18- or 20-ft. section each day, working on alternate days in the north and south portions of the tunnel, so that each section of

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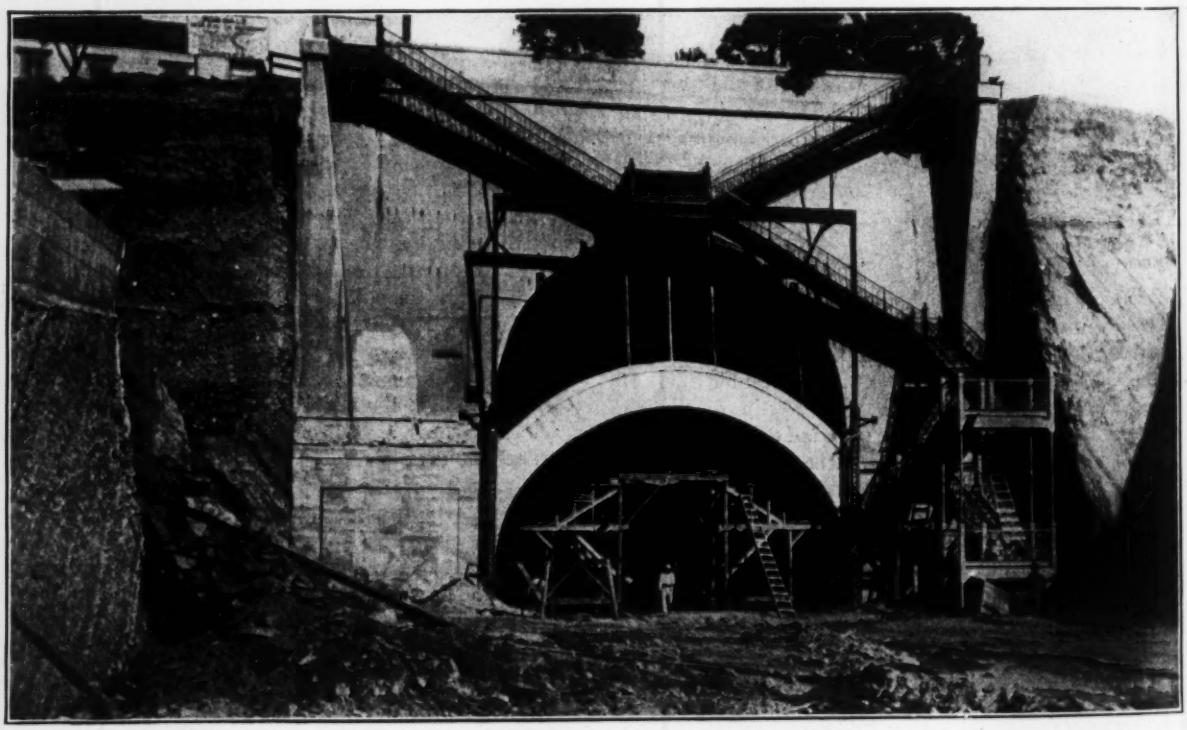


FIG. 1. PARTIALLY CONSTRUCTED SOUTH PORTAL OF TUNNEL NOW COMPLETED UNDER AN OLD TUNNEL

brickwork had one day to set before the centers were struck. Some concern had been expressed about the thinness of the arch and the length of the span; but this anxiety proved unfounded, as no trouble whatever was experienced. The top of each section was plastered the evening of the day it was laid. After all brickwork and top plastering were finished, the entire upper surface was coated with hot asphalt. In doing this, barrels of asphalt were rolled around on the arch without vibration being noticed.

Tile-setting likewise was carried on in two sections, using two 50-ft. movable scaffolds. Great care had been exercised in constructing and setting up the centering for the brickwork, in order to obtain a perfectly true bore throughout the tunnel. As a result, it was possible to start the tile at the bottom on both sides of the tunnel and make a perfect closure at the top without the use of variable-width key tile, and this was done. The procedure in underpinning and some of the costs were as follows:

1. A steam-shovel cut about 7 ft. deep was taken out through the entire length of the tunnel, leaving enough material along the walls to support them. This first excavation amounted to 6,554 cu.yd., which was taken out in 33 days by a crew consisting of 1 shovel engineer, 1 foreman and 2 laborers. The total labor cost to load the material on wagons and motor trucks was 7¼c. per cu. yd. The earth was hard, stratified clay or soft shale, which would stand vertically with excellent supporting qualities.

2. Underpinning sections were excavated at points 10 ft. apart, and the underpinning concrete was poured section by section. The concrete mixer was mounted on wheels, so that it could be pulled by horses from section to section. Its crew consisted of 1 foreman, 1 mixer engineer and 5 or 6 laborers. The average day's work was 39.3 cu.yd., the labor cost of mixing and placing being 61.5c. per yd. This cost refers only to the concrete that was chuted from the mixer directly into the walls. Concrete for the top layer, which was about 1 ft. thick, was mixed by hand to a stiff consistency and rammed in horizontally, to insure firm contact with the bottom of the old masonry.

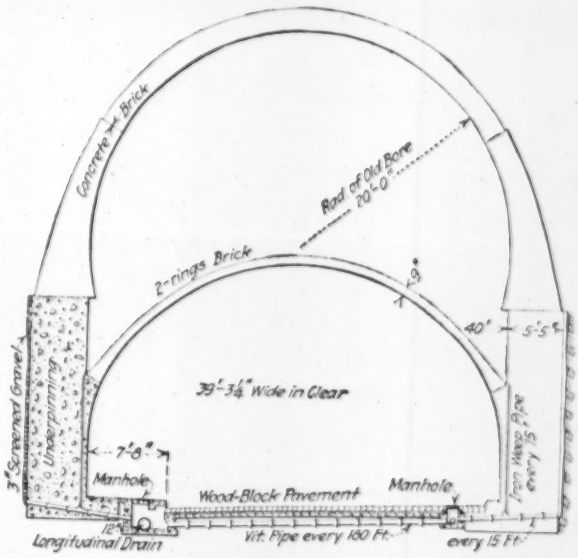


FIG. 3. CROSS-SECTION OF OLD AND NEW TUNNELS, SHOWING DRAINAGE SYSTEM

3. After completion of the underpinning, another steam-shovel cut removed all earth between the walls down to pavement subgrade.

4. Stone cutters working with hand tools did such cutting away of the old concrete as was necessary to make it clear the new brick arch. This work was necessary in the northerly portion of the tunnel, where the grade change was insufficient to cause the new arch to clear the old, particularly at the abutments.

5. After trimming the old masonry, the centering was erected and the new arch laid. The average number of bricks laid by the daylight shift was 2,230 per mason per day. The single mason with 3 helpers, who worked on the night shift, laid 900 bricks to key the arch and plastered 18 or 20 lin.ft. of extrados each night. The labor cost of wetting, hoisting and laying the brick (at $5 per day of 8 hr. for bricklayers and $2.50 per day for laborers) was $6.86 per 1,000. This was accomplished under specifications that were very strict as to quality of work. All brick were laid as stretchers with broken joints, and when any unfilled joints were found, both the defective work and the mason were removed.

The plans were prepared in the city engineer's office under the direction of Homer Hamlin, City Engineer. The contractor for the entire work is Lynn S. Atkinson, of Los Angeles. The total contract price is $189,900.

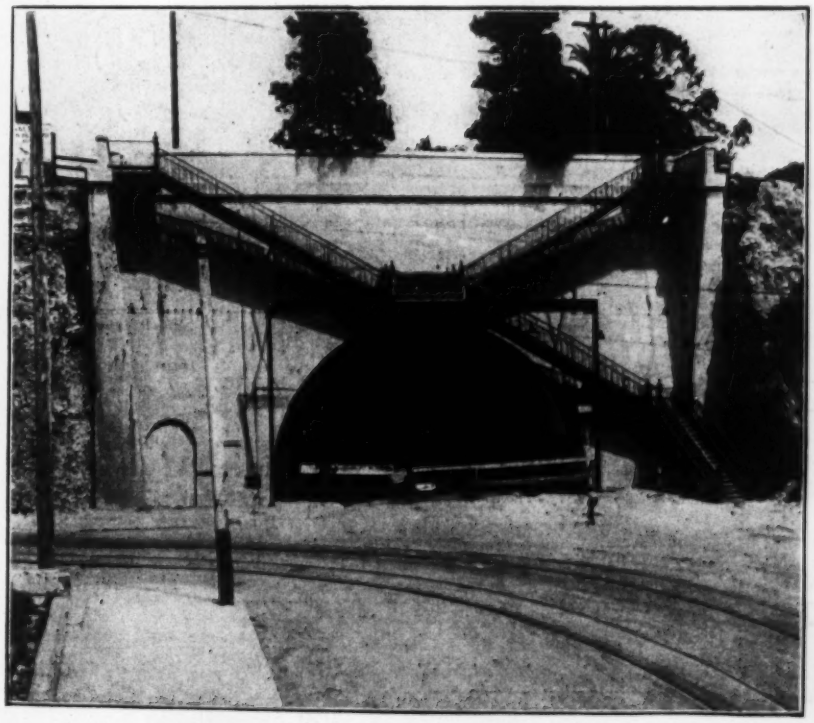


FIG. 2. SOUTH PORTAL OF OLD TUNNEL BEFORE LOWERING

New Coal Shipping Station at East St. Louis, Illinois

A coal shipping plant of novel design, for the purpose of transferring coal from railway cars to river barges, is being built at East St. Louis, Ill. It will have a capacity of shipping 150 tons per hr. In design it is based upon the principle of the transfer inclines for car-ferries on the Ohio and Mississippi rivers.

From the coal yard a supply track extends along an embankment adjacent to the inner harbor line, and having a trestle over the head of an incline which extends (at right angles to the supply track) down the river bank. The incline has a grade of 12%, and on it is a track of 6 ft. gage upon which rides a cradle built of structural steel. The deck of the cradle does not come to the level of the deck of the boat, as for a car-ferry, but is on an ascending grade of 20.35% in order to have the end at proper height for dumping. The cradle is carried on eight 33-in. car wheels and weighs about 22 tons. It is moved up and down the incline to follow the stage of water level in the river.

The railway car on the trestle of the supply track dumps the coal into a track hopper of 12 tons capacity from which it is discharged as required into a transfer car. This car runs on the 6-ft. track of the incline and up the cradle to a dumping platform, whence it discharges its load into the barge below. The general arrangement of the plant is shown in the accompanying drawing. The tracks are laid with 80-lb. rails. On the cradle incline the ties are 8x8 in., 10 ft. long, 18 in. c. to c., with spacing blocks 6x8 in. to prevent creeping.

The operation is effected by means of three cables, two to handle the coal transfer car and the other to handle the cradle. The drums for the cables are arranged in the operating house and are driven by gearing from an electric 35-hp. motor. One man controls the movements of the drums by the levers, and also operates the gate

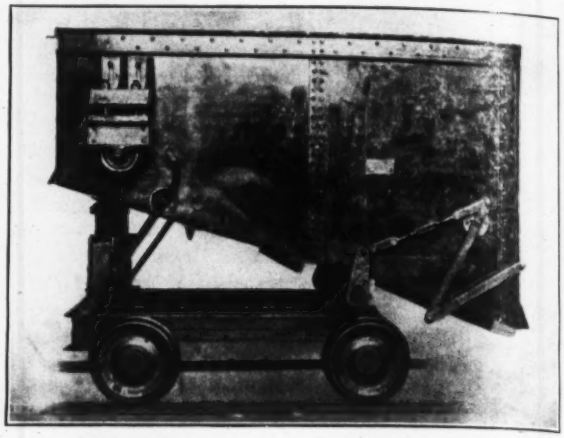


FIG. 2. 12-TON DUMP CAR FOR COAL-SHIPPING CRADLE

of the track hopper by means of a hand wheel with sprocket wheel and chain.

The hauling cable *A* extends along the center of the track down the incline and through the cradle to a 30-in. pulley, then up to a 36-in. pulley at the track level, and has its end attached to the transfer car. The back-haul cable *B* also extends down the center of the track, but leads up the deck of the cradle and is attached to the car. Both cables are carried on 6-in. idler pulleys spaced about 10 ft. apart. The cradle cable *C* leads from the drum down one side of the incline and crosses through the upper end of the cradle. It returns along the opposite side of the incline, and its end is anchored at the trestle carrying the overhead supply track. Normally the cradle will be held in position by a ratchet brake on the first pair of wheels.

The transfer car has an end-dumping body pivoted to bearings on the frame. It stands under the hopper to receive its load, and is then hauled along the incline and

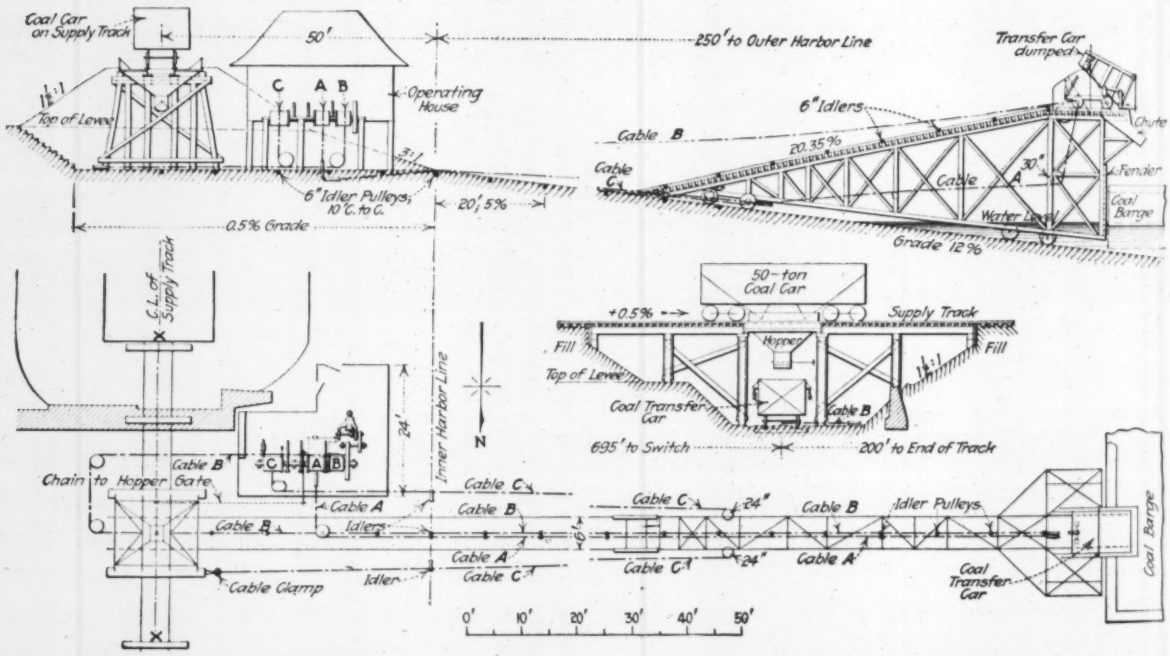


FIG. 1. COAL-SHIPPING STATION FOR LOADING RIVER BARGES AT EAST ST. LOUIS, ILL.

cradle. At the dumping platform, lugs on the side of the body engage with inclined guide rails, by which the body is raised at the rear (pivoting on bearings), while the forward end drops and the end door swings open, giving free discharge of the coal into the delivery chute. As the car is hauled back, the body drops into place on the underframe and is latched. The speed is variable, up to about 300 ft. per min. for the car both loaded and empty.

The cradle, transfer car and operating machinery have been built by the Weller Manufacturing Co., of Chicago. The coal shipping plant is for the Wiggins Ferry Co. The construction of the yard, approaches and tracks is being done by the latter's forces. The design and construction are under the direction of H. J. Pfeifer, Engineer of Maintenance-of-Way of the Terminal Railroad Association of St. Louis. The cost will be about $11,500 exclusive of the embankment for the supply track.

Experiments in Checking the Slides at Panama

The *Canal Record* of Jan. 5 publishes a special supplement containing an illustrated paper by Gen. George W. Goethals describing the Panama Canal slides and the methods adopted for dealing with them. For the most part the paper covers the same ground as that contributed by General Goethals to *Engineering News* of Nov. 25, although the subject is discussed in greater detail.

A notable feature of the article in the *Record* is a review of some of the experiments that have been made in attempting to check the progress of the slides. There is a more or less prevalent idea in the United States that the engineers on the isthmus have paid no attention whatever to any plan for stopping the slides other than to excavate the material as fast as it slips down into the prism. It is worth putting on record, therefore, that a number of methods for checking the slides, suggested by engineers, geologists and others, have been actually tried at the isthmus.

We append an extract from General Goethals' paper in the *Canal Record* summarizing these various experiments:

The various slides began without any warning, and there were no means of determining the extent to which they would proceed. Various attempts were made to check them, but all without success. There is no question that the excessive rains were responsible in a great measure for most of them and for the difficulties that resulted because of them; yet some of the most troublesome ones occurred during the dry season. Drainage proved ineffective. The rains, which cover a period averaging nine months of the year, so thoroughly saturate the ground that, though the surface may be dried out by the wind and sun during the remaining three months, the ground water remains. Because of the great depth of the cutting subsurface drainage could not reach the ground water sufficiently deep to be effective, even if the excessive cost involved warranted such a procedure. It has been suggested that artificial heat be applied through pipes, but the cost precluded such a method of relieving the situation; furthermore, the relief would be temporary.

Planting the slopes with grasses and vegetation prevents, to a certain extent, the erosion that follows some of the heavy downpours, but even in places where this has been done the results anticipated were not secured. The trees that have been standing on the banks for years slide down, standing erect in their normal positions, with slides of the second class and in the movements that take place subsequent to the "breaks."

Piling was tried with the hope that with the ends of the piles in firm ground the loose or moving portion might be retained in place. This also proved a failure, and along some portions of the banks are now seen piles projecting at various angles and at different elevations, though originally the piles were driven vertically and they were properly aligned.

Where the moving mass was clayey material loosened up by the movement and by the rains, a covering of heavy riprap was resorted to with the hope that their weight would carry the pieces of stone through the mass to the solid ground below and thus check, if not stop, the movement; much of this riprap was subsequently removed from the prism by the shovels.

It was believed that blasting was in some measure responsible for the slides, on the theory that the shaking up of the banks, caused by the blast, destroyed the cohesion of the particles in the banks, resulting in their breaking down, so that steps were taken to reduce the depth of the holes and the amount of explosive used, in order to lessen, if not remove, any source of trouble on this account.

It was learned that in experimenting with clays for the manufacture of pottery the Bureau of Standards has discovered a means of removing the slipperiness from the clays by inoculating the soils with a simple and inexpensive solution. With the hope that some such method of preventing the slides might prove effective with the soils on the isthmus, samples were sent for experimental purposes along these lines, but it appears that these clays are of an entirely different character, and no method of treatment has yet been evolved to secure the results desired.

The construction of retaining walls to withhold the moving masses was not possible, for access to the sides of the prism where the walls belonged could not be had. When access was possible, the movement had ceased, there was no evidence of any further movement and the desirability of or necessity for walls no longer existed.

Some of the sandstones and shales in the cut when exposed to the air disintegrate, but harden when kept constantly wet. Where disintegration occurred, the resulting soil would grow grasses and vegetation, and steps were taken to protect the slopes and the underlying material in this way, assisting nature to some extent in a country where vegetable growth springs up and expands rapidly.

Experiments were made with cement covering applied to the banks by the cement gun and by concrete held in place by rods embedded in the rock; neither proved successful, and they were abandoned.

When the use of concrete proved a failure, the geologist thought that experiment might develop a solution which, applied to the face of the sandstones and shales, would combine chemically with the substances in these rocks, so as to form a coating of glass. Experiments were made, but no satisfactory solution obtained.

With the breaks, except those which occurred in the vicinity of La Pita Point, lightening the banks, where this could be done, secured good results, as did also the sluicing of the upper portions of the hills around Cucaracha slide into the valley on the opposite side of the hills from the prism; but in all other cases the only effectual method found was to allow the material to enter the cut and remove it. This procedure has resulted in bringing all the slides to a state of rest, and with the exception of those now active none of them has given any trouble since, for there has been no movement of any kind in any of them after all the material that was in motion had been removed or come naturally to rest.

It is certain that the troubles are due to the failure of underlying strata, because these were unable to bear the weight that the banks brought upon them. Under the circumstances it is difficult to understand the impression that has gained credence in some quarters that a sea-level canal would have avoided the difficulties encountered, since the cutting would have been through the same material, but at least 80 ft. deeper.

It is also certain that nothing can stop the movements now in progress until the angle of repose is reached for the materials under the conditions that exist and that this can be reached only by removing th excess amount of material. If experience counts for aught, then that gained in the handling of the slides and the breaks that have occurred along the line of the canal leaves no doubt that the means adopted and now in use will effect a cure in the slides that now close the canal; furthermore, that when cured, no further troubles need be anticipated from slides in this locality.

Municipal Ownership of water-works, electric light and power plants in Kansas is thus summarized by "Kansas Municipalities": Of 206 water-works in the state, no less than 191, or 92.71%, are under public ownership. Of 166 electric light and power plants 88, or 53%, are municipally owned. There are in Ohio 110 and in Michigan and Minnesota 101 each of municipal lighting plants, but the percentage of municipal ownership is not as high in these states as in Iowa.

Field and Office

Building Concrete Piers for Sciotoville Bridge

The plant layout for the substructure work on the Chesapeake & Ohio Northern Ry. bridge over the Ohio River at Sciotoville, Ohio, was dictated by the necessity of getting sand and gravel in by river. A total of some 27,000 cu.yd. concrete and 850,000 lb. reinforcing steel was involved. The work comprised three river piers and twenty-four land piers.

On each bank an incline with narrow-gage track was erected, leading from low water to 40 ft. above the top of the bank (see layout plan, Fig. 2). The Ohio incline, the longer of the two, led up from a crib supporting a revolving or "whirler" derrick.[1] The Kentucky incline was served by a derrick boat. The engines of the inclines were of the direct-hoist type with large drums. All parts of both inclines worked satisfactorily throughout the season and a half that the work required.

The sand and gravel for concrete were obtained from a river bar a few miles below the site by means of a ladder dredge on which the sand and gravel were washed and screened. Flatboats delivered the material to the inclines, where it was unloaded with clamshell buckets.

At the top of the incline the skip dumped just below the head pulley and directly over a partition separating the sand and the gravel, there being a tilting apron on top of the partition, under the skip. The gravel used ran from ¾ to 3 in., undersize and oversize being wasted.

Materials for 8,000 cu.yd. of concrete were delivered to each bank, including that for the Ohio shore pier. All cement came in via the Norfolk & Western Ry. on the Ohio side. Cement for the Kentucky (south) viaduct, the Kentucky shore pier and the center pier was sent down the Ohio incline to flatboats, that for the Kentucky viaduct going up the Kentucky incline and that for the two larger piers going to the floating mixer plant.

The work was simplified by unusually good foundation conditions. In the river, rock was within easy reach. This was an important advantage, as on account of the structural type of the river span—two 775-ft. continuous truss-spans resting on three piers—it was necessary that there be no settlement of these piers.

The middle, or river, pier, which is the largest pier of this bridge, measuring 18x63 ft. under the coping and rising 96 ft. above low water, was built by means of a cofferdam. Work on this pier started late in October, 1914. A double-wall box coffer-dam was built, 79x127 ft. outside and 14 ft. high. At this spot the elevation of the river bottom, of practically bare rock and fairly level, was at low-water level. The 10-ft. space between the walls of the coffer-dam was filled with sand and small gravel, dredged from the river near-by, and decked over with 2-in. plank.

On account of the great rises of the river it was known from the beginning that the coffer-dam would be sub-

[1]See "Engineering News," Sept. 9, 1915, p. 506, for description and drawing of the Dravo "whirler" derrick.

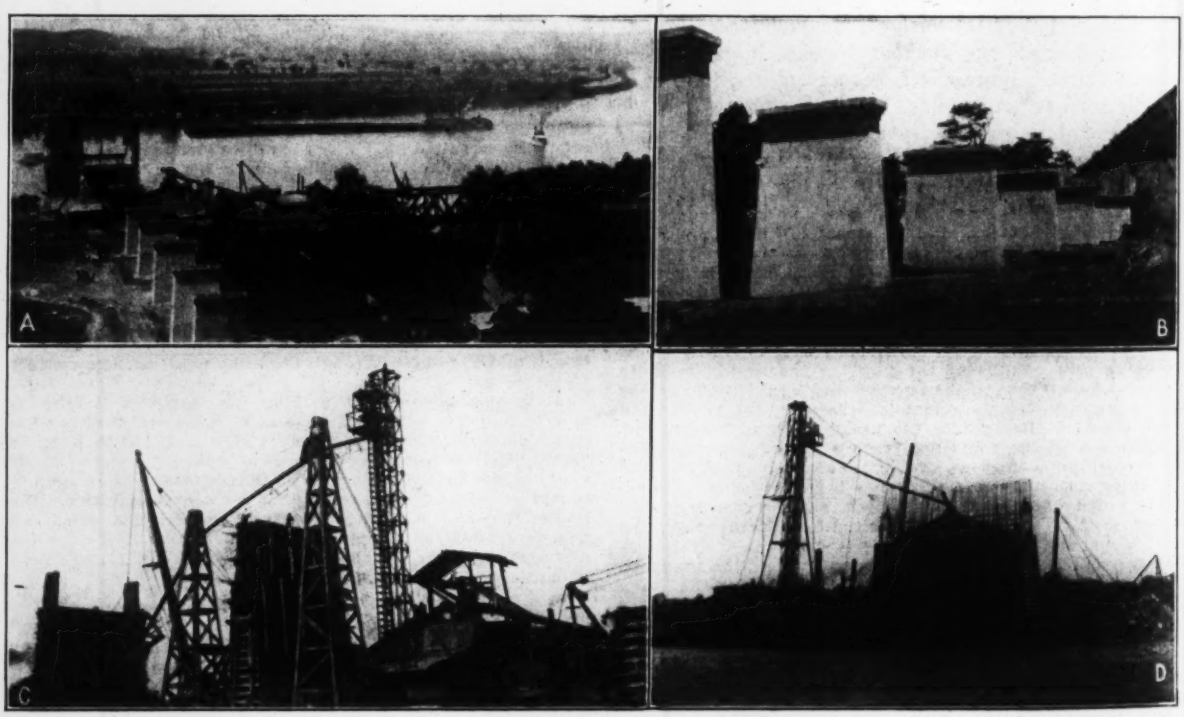


FIG. 1. VIEWS OF SCIOTOVILLE BRIDGE PIER CONSTRUCTION

A—Looking south along line of bridge; Ohio viaduct, north shore pier and center pier in place. B—Piers of Ohio viaduct. C—Spouting concrete to pier of Kentucky viaduct. D—Floating plant spouting to center pier

merged at all stages above a moderately high river. It was in fact submerged continuously for four months, but in the spring was found not to have moved, and practically no fill was washed out.

Inside the coffer-dam, open excavation was carried on by means of derrick boats to a depth of 10 ft. into the rock all over. The size of the footing is 40x85 ft. One No. 4 Emerson pump was used to keep the coffer-dam dry; it did not run at full capacity. Excavation was 30% completed on Dec. 4, 1914, when work stopped for the season on this pier. Work was resumed Mar. 29, 1915, the river being unusually low for this time of the year. The footing course was poured April 8.

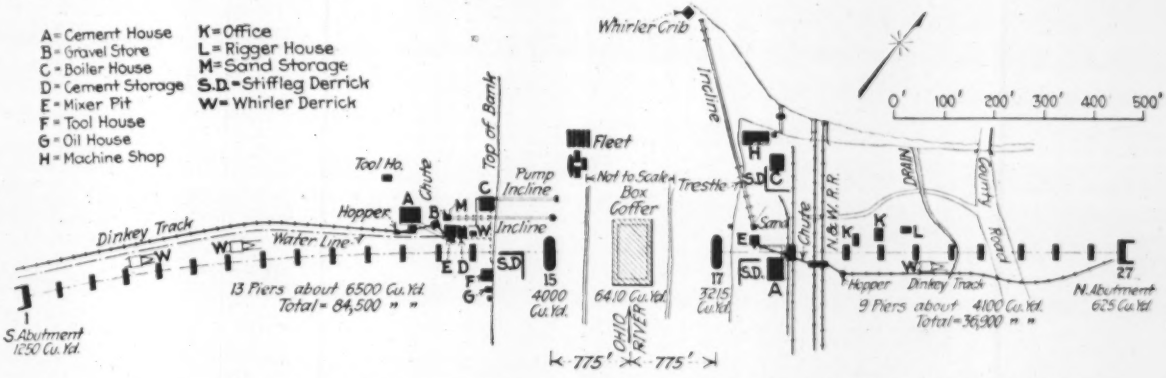


FIG. 2. DRAVO CONTRACTING CO.'S PLANT LAYOUT FOR SUBSTRUCTURE WORK ON SCIOTOVILLE BRIDGES

The Ohio shore pier was built in open excavation 24x70 ft., extending 8 ft. into the rock and high enough up the bank to be dry at ordinary river stages.

The Kentucky shore pier was sunk by open dredging through wells. It was so designed that it could have been converted into a pneumatic caisson at any time if it had become necessary. The pier cylinder is 24x70 ft., with semicircular ends. Excavation with orangepeel bucket, through four wells, was carried on with working chamber and wells flooded, after the first 5 ft. until gravel was reached. The pier went through 25 ft. of fine sand and 2 ft. of coarse gravel, and the final excavation (in the dry) was carried an average of 2 ft. into the rock. The sinking was successfully done in 16 working days for excavating only. The cutting edge was sealed and the working chamber kept dry while filling with concrete. The river was up around this pier during practically the whole period of its construction. The top of the pier cylinder was 28 ft. above the cutting edge, the working chamber was 6 ft. high, and the wells were 7 ft. 3 in. in diameter.

Both shore piers are 12x67 ft. under the coping. The Kentucky viaduct piers and abutment, with an average load of only 2½ tons per sq.ft., rest on a clean sand with depth of excavation averaging 8 ft., except the pier at the top of the bank, which goes down 25 ft. on account of possible scour of the bank.

Of the Ohio viaduct piers five rest on shale, while five are on rock, as is also the abutment. The second pier south of the county road was rather deep, on account of a gully. The abutment had to be stepped into the face of a hard shale cliff. Otherwise the excavation was very simple. The rock bottoms needed but little pointing to give level beds for the foundations.

The excavation for both viaducts was handled by whirler derricks on a track parallel to the line of piers. There were a 5-ton and a 10-ton whirler on the Kentucky side and a 5-ton on the Ohio side. Work at both shore piers was handled by a stiffleg derrick.

There were three concrete-mixing plants—a floating plant, and two fixed plants, one at the shore end of each incline. All these plants had 1-yd. mixer, 100-ft. tower, and chutes. The floating plant was served by a derrick boat which transferred cement and aggregate from flatboats direct to the mixer bins. With the aid of chutes this floating mixer poured all of the center pier and all except the coping of the Kentucky shore pier.

The chutes from the fixed plants were able to deliver concrete direct to the Ohio shore pier and to one pier of the Ohio viaduct and several of the Kentucky viaduct. For the remaining piers and abutments of the two viaducts the chutes spouted the concrete into hoppers, and from there it was carried by bottom-dump buckets on a dinkey track along the line of the piers (between them and the whirlers) to the pier where needed. On the Ohio side the hopper sat on the north side of the Norfolk & Western Ry. tracks, the chute from the mixer tower running over the tracks on a temporary bridge.

The viaduct piers are all rectangular in plan; all except two are 5x26 ft. under the coping and average 40 ft. in height. Slab forms were used in sections 16 ft. high and, for the sides, long enough to extend by the ends. These slabs were very substantial; they as well as the end bulkheads were made with vertical ¾-in. sheeting, 2x10-in. horizontal studding and 8x8 rangers. The tie-rods were fitted with a sleeve-nut 1 to 2 in. back of the face. The coping is somewhat complicated, but a well-made form of two sides and end bulkheads was built. Only two of these forms with minor repairs lasted throughout the job.

On the large river piers some of the slabs and a few of the round end forms were used more than once, but most of the forms for these three piers, including all of the three copings, were built new for each pier. Below the coping the forms were in 16-ft. lifts.

About 150 cu.yd. of concrete was usually poured in 10 hr., but on several occasions 300 to 350 cu.yd. was poured in 10 hr.

The bridge and approaches were designed and are being built under the direction of Gustav Lindenthal, Consulting Engineer, for whom O. H. Ammann acts as Principal Assistant Engineer and R. T. Robinson as Resident Engineer. The Dravo Contracting Co., Pittsburgh, Penn., was the contractor for the substructure. The plant layout was made by J. J. Nolan, and the subsequent work was under J. Smith Miller as superintendent.

Concrete Coal Cylinders Built with Moving Forms

By Charles H. Higgins*

The new retail coal plant of O. H. Perry & Son, Inc., at the foot of East 19th St., New York City, consists of three parts: (1) The concrete coal pockets; (2) the coal-hoisting machinery, headhouse and appurtenances, and (3) the office-scale house. Each part was constructed under a separate contract by different contractors.

The concrete coal pockets consist of a group, or battery, of nine cylinders, each of 18 ft. in inside diameter, supported on a reinforced-concrete platform of columns, girders, beams and slabs, and two additional concrete cylinders of the same diameter and similarly supported, located alongside the main battery and intended as a re-screening plant. In general the supporting structure consists of four rows of reinforced-concrete columns 18 ft. apart, each row consisting of from seven to nine columns. These support a platform of beam and slab construction, intended to support the cylindrical pockets, at such an elevation as to give 12 ft. clear headroom above the street level. Between each of the four rows of columns there is a driveway.

The sea wall affords a foundation for the row of columns nearest the river, and for each of the other three rows a foundation was provided consisting of wooden piles driven to refusal, cut off below water level and each row capped with a concrete wall and footing extending to within 2 ft. of the yard level and reinforced with steel near the top.

After the completion of the platform circular forms were erected for all nine cylinders, to a height of 4 ft., the plan being to cast the cylinders in a continuous operation by moving the forms up steadily as the concrete was poured. This is the type of construction developed in the West for grain bins, and it has recently been extended to coal pockets.

The walls of the cylinders were to be of concrete 7 in. thick, reinforced with 1-in. and ¼-in. steel bands spaced at varying intervals from the bottom to the top. The forms were constructed 4 ft. high and (for each cylinder) consisted of two outer and inner rings, each ring being made up of three thicknesses of 2-in. lumber sawed to the proper circumference and bolted together to break joints. Each pair of rings (the outer and the inner) was lagged with 2-in. lumber 4 ft. long, the ribs being located 2½ ft. apart, vertically and the lagging projecting correspondingly, as indicated in Fig. 2.

Between the outer and inner forms of each cylinder there were placed at regular intervals, in a vertical position, six 1-in. round steel bars, with the lower end on the platform. The rods were about 20 ft. long, and each extended through a heavy yoke made up of structural-steel members. Each yoke extended across the inner and outer form with a down-standing leg of angle iron 4 ft. long. Each vertical rod extended through a yoke, while a screw jack seated on each yoke and gripping each rod afforded means of lifting the forms by turning the jacks, which reacted on the rods.

A conventional concrete-hoisting tower some 70 ft. high had been erected at one side, with a batch mixer located in a pit at the foot.

The plan was to work continuously, concrete being poured in all cylinders and the band reinforcement being placed at the proper intervals as the concrete rose. The band reinforcement was secured to the vertical rods by wires. While some workmen poured concrete, others turned the jacks and raised the forms. Great care was taken to give each jack the same turn and to keep all forms moving together and plumb. The plan was to pour concrete continuously for two shifts of 8 hr. in each 24 hr., with an interval of 4 hr. between each shift, during which time the forms were kept moving by two men, who walked back and forth, giving each jack a turn. The work proceeded at the rate of about 6 ft. in each 24 hr., the forms, wheeling platforms, stanchions to carry the electric lights, etc., being carried up continuously by the movement of the jacks. At night the work was lighted by electric lamps hung from timbers.

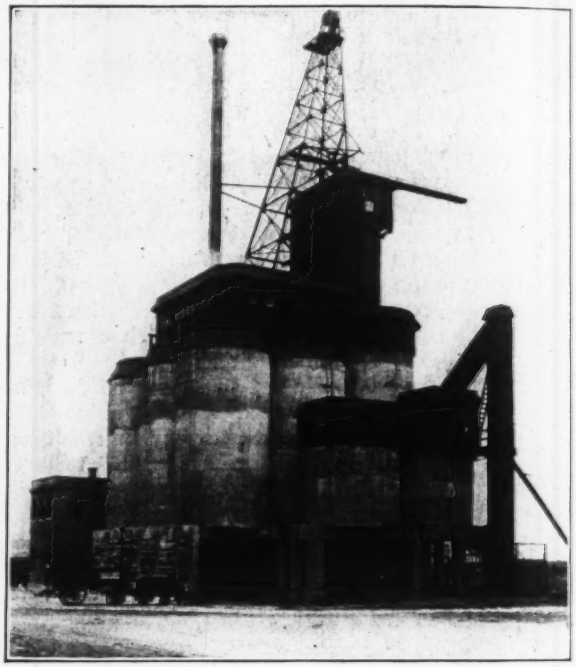
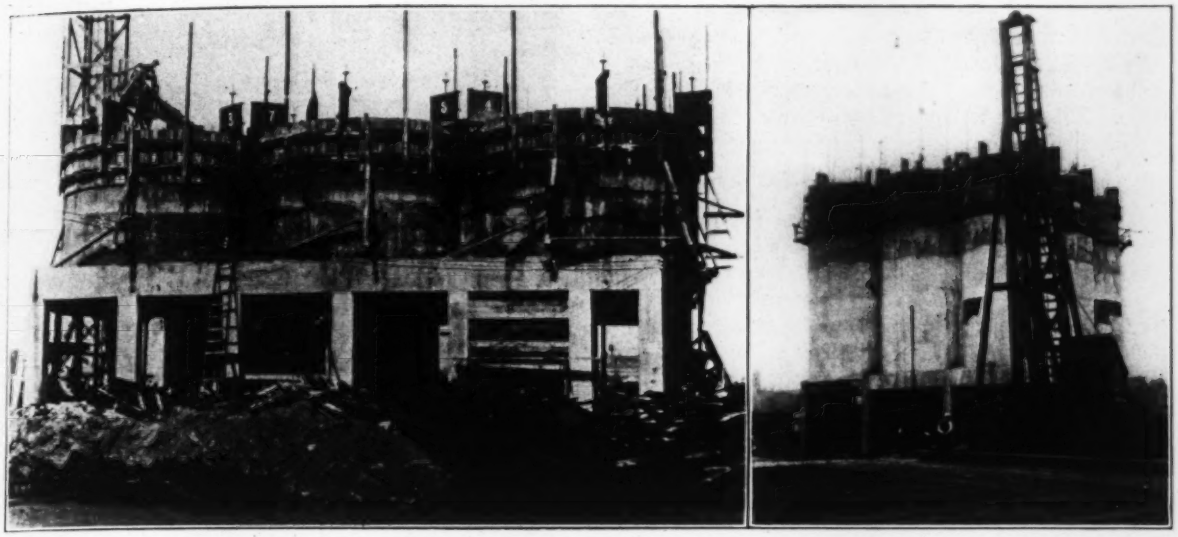


FIG. 1. COAL-STORAGE CYLINDERS BUILT WITH MOVING FORMS

In Fig. 3, which shows the work nearing completion, there is visible at the top a hanging scaffold, which was suspended from the outside of the forms and carried up with them. On this scaffold two men pointed up, rubbed and roughly finished the exposed surface. A high degree of finish was not aimed at, nor would it be possible by this means, as there is always a certain amount of cement-bearing water running down over the finished work.

The work progressed nicely, with no serious mishaps and with few difficulties. The most serious of those encountered may be seen in Fig. 3. The "prison windows" in this view are actually what is known as "pulls" and result from the concrete sticking to the forms and being pulled up as they advance, the reinforcement being left exposed to view. In general these were stopped at their very beginning by the alertness of the superintendent in charge; but in the cases seen in the photograph they progressed to such an extent that it was

*Consulting Engineer, 30 Church St., New York City.



FIGS. 2 AND 3. TWO VIEWS OF THE CONSTRUCTION; NOTE "PRISON-WINDOW" EFFECT WHERE FORMS STUCK

necessary to go on up, leaving an opening behind, which was later filled in by means of stationary forms and grouting. Very good results were obtained in repairing these openings, but the process is expensive, tedious and altogether to be avoided. It is probable that the more serious of these pulls resulted from the outside form at the critical spot not remaining perfectly vertical, the lower not moving in and pinching the concrete while the latter was still soft.

There were some delays in the program, the first resulting from an almost torrential rainstorm that drove the men off the work, the second, and more serious one, from the failure to deliver anchor bolts on time. As these anchor bolts—intended to hold the steel tower and machinery—had to be set in the concrete of the cylinders, it became necessary to stop work for a day or two. In each case, however, the forms were moved again successfully, and no more serious damage than a slight ridge resulted.

The concrete set nicely and the work, which was finished in the summer, now appears sound and serviceable, after coal has been in the pockets for some weeks.

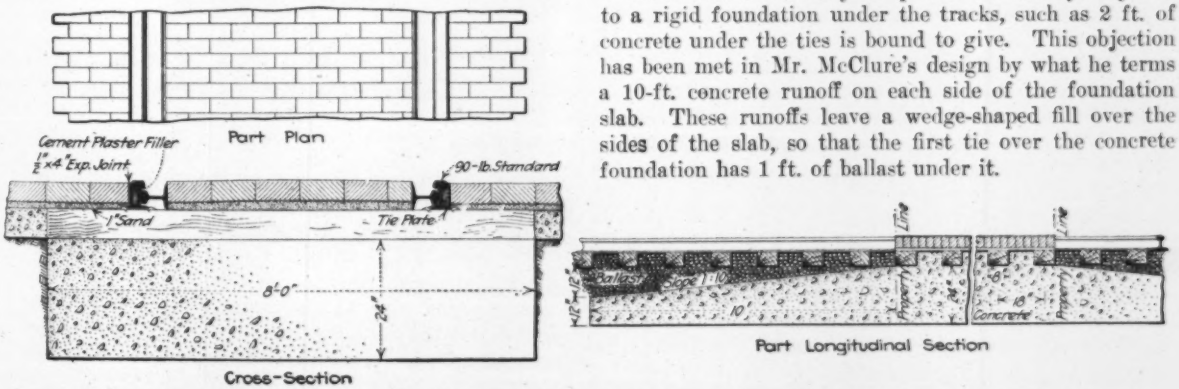
The construction of the rescreening pockets on the same principle was not determined upon until the main cylinders were reaching completion. Otherwise, they might have been carried up with the main cylinders. As it was, part of the forms taken off the main cylinders were used and the lower rescreening cylinders similarly constructed, for even in the case of two cylinders only 15 ft. high it appeared from the estimates that economy would result from the use of moving forms.

Ralph H. Perry was interested in the construction from the point of view of the owner. The writer was consulting engineer, preparing the plans, letting the contracts and supervising the construction. The General Contracting Co. built the foundations and the concrete coal pockets. The office-scale house was erected by Hugh Getty, Inc., the Fairbanks Co. furnishing the scales.

Railway-Crossing Pavement with Wedge Runoff

The city engineer of Oklahoma, Okla., Guy V. McClure, after a thorough trial has adopted as standard for railway street crossings the type of pavement construction shown in the accompanying illustration. Mr. McClure is a former railway construction engineer, and he has endeavored to design a crossing that will be satisfactory from the railway as well as from the pavement point of view.

Heretofore the railway companies have always objected to a rigid foundation under the tracks, such as 2 ft. of concrete under the ties is bound to give. This objection has been met in Mr. McClure's design by what he terms a 10-ft. concrete runoff on each side of the foundation slab. These runoffs leave a wedge-shaped fill over the sides of the slab, so that the first tie over the concrete foundation has 1 ft. of ballast under it.



STANDARD CONSTRUCTION FOR PAVEMENT OVER RAILWAY CROSSINGS, OKLAHOMA CITY, OKLA.

The effect of the sloped approach slab, with ties ballasted from 1 ft. down to nothing, is to take away the shock that would otherwise result in passing from the ballasted roadbed to the solid concrete-pavement foundation. This type of construction has been found to work satisfactorily even under the heaviest railway loadings.

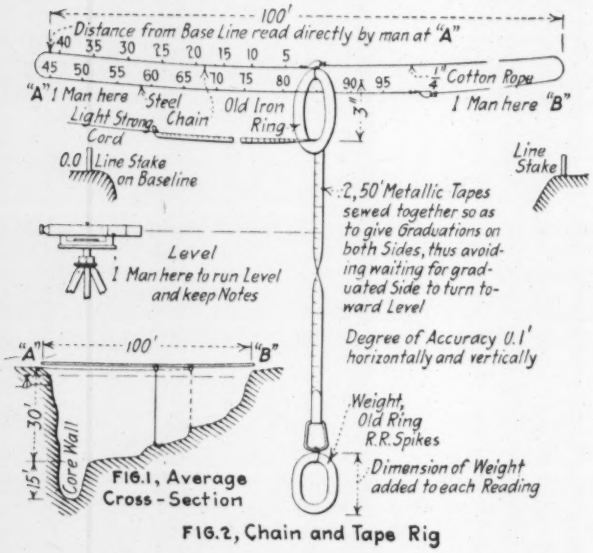
These crossings are installed by municipal day labor for about $5.40 per lin.ft. of track, including 10% for supervision and overhead charges, but not including the track itself, which of course is furnished by the railway company. The railways have turned over all construction work to the city. The cost of materials is: Sand, $1.50 per cu.yd.; stone, $1.60 per cu.yd.; cement, $1.50 per bbl.; paving brick, $16 per M. This method of construction requires that the track be out of service 72 hr.

Cross-Sectioning Device on Dam Excavation

By J. O. P. Coulling*

In excavation work for the new Loch Raven dam of the Baltimore Water Department the average cross-section was as shown in Fig. 1. To take a fairly accurate section by means of the ordinary rod-and-level method was laborious and dangerous. An easier method was therefore worked out and used successfully.

With an old 100-ft. steel chain and 100 ft. of ¼-in. cotton rope an endless chain was made, as shown in Fig. 2. At the zero end of the 100-ft. chain a 3-in. iron ring


100'
Distance from Base Line read directly by man at "A"
40 35 30 25 20 15 10 5
45 50 55 60 65 70 75 80
90 95
1" Cotton Rope
"A" 1 Man here
Steel Chain
Old Iron Ring
1 Man here "B"
Light Strong Cord
0.0 Line Stake on Baseline
Line Stake
2,50' Metallic Tapes sewed together so as to give Graduations on both Sides, thus avoiding waiting for graduated Side to turn toward Level
Level
1 Man here to run Level and keep Notes
Degree of Accuracy 0.1' horizontally and vertically
"A" 100' "B"
30'
15'
Core Wall
Weight, Old Ring R.R. Spikes
Dimension of Weight added to each Reading
FIG. 1, Average Cross-Section
FIG. 2, Chain and Tape Rig

FIGS. 1 AND 2. CROSS-SECTIONING RIG USED AT LOCH RAVEN DAM

was fastened, through which a double 50-ft. metallic tape (two tapes sewed together so as to give graduations on both sides) weighted at the zero end was passed. A light strong cord was tied to the 50-ft. end of the tape.

Having set stakes on both sides of the excavation on the lines of the sections required and stretched the chain across, the wye level was set up a little lower than the chain. Then starting with the zero end of the chain at point *A*, the ring was pulled out over the section, and at the breaks the metallic tape was let down until the

*2431 East Federal St., Baltimore, Md. Formerly Assistant Engineer, Baltimore Water Department, on Loch Raven dam construction.

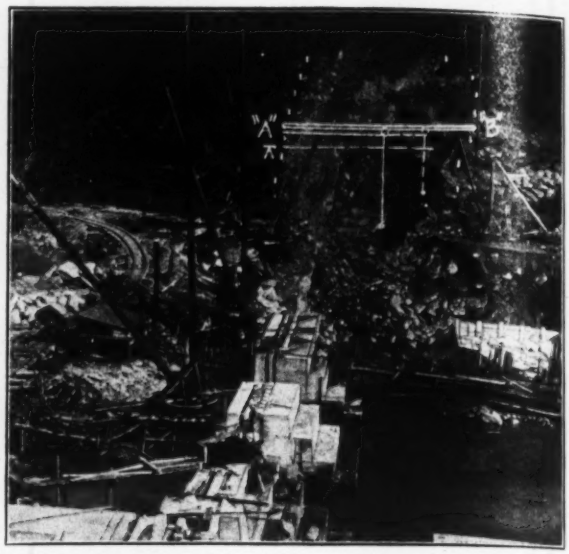


FIG. 3. LOCH RAVEN DAM UNDER CONSTRUCTION
White lines are drawn to show how cross-sectioning device was used

weight on the end touched the excavated surface. At such points the horizontal distance from the base line was read directly from the chain by the man at *A*. The original surface on both sides of the excavation was about the same elevation for each section, and no correction had to be made to obtain the horizontal distance. The rod reading was taken from the metallic tape. Readings as high as 40 ft. were secured. When one section was complete, the next was taken backward—that is, from *B* to *A*—the horizontal distances still being read by the man at *A*. The chief of party (at the level) and a man at *A* and *B* were sufficient to take the sections, although much better time was made with an additional man at the instrument.

Sections taken in this manner were correct within 0.1 ft. horizontally and vertically, and a great deal of hard climbing and wasted time in making numerous set-ups was avoided. The men at *A* and *B*, however, found the narrow chain and small rope hard on their hands and were compelled to wear heavy gloves.

The view, Fig. 3, shows the character of the excavation. The only possible way to cross the nearly perpendicular rock face in the background was by a rope fastened to one of the trees above. The possibility of the rope breaking or coming unfastened, and the chance of starting loose material, would have made this extremely dangerous.

New Formulas for Weights of Girders and Trusses

By A. G. Hayden*

The following formulas for weight of girders and trusses in terms of the span length, depth, load and allowable stress have been found useful by the writer, particularly in making estimates for comparative designs of the same bridge, without the necessity of determining the girder-flange sections or the sections of the truss members and making estimates from the stress sheets. In general the formulas have been found as reliable as estimates from stress sheets in cases where the percent-

*Bridge Designer, New York State Barge Canal, Albany, N. Y.

age of details is assumed. In comparison with the detailed estimates of many girders and trusses, the results obtained from the formulas have been found to be close, except in cases of inconsistent design.

It must be observed that difference in office practice as to details may require modification of the constants in the formulas, and that in any case marked peculiarity of design, particularly of trusses, may make the formulas inapplicable if very close results are desired.

Derivation of Plate-Girder Formulas

The average gross flange area for plate girders of variable flange section is about equal to the net area at the point of maximum moment. Details (stiffeners with their fillers, splice plates, rivets, etc.) are assumed to be 30% of the weight of the main section (flanges and web).

Let

M_t = Maximum total bending moment, including that due to the weight of the girder, ft.-lb.;
L = Span length, ft.;
f = Allowable stress, lb. per sq.in.;
h = Depth of girder, ft.;
t = Thickness of web, in.

If one-eighth the gross area of the web is counted as effective flange area, the total weight of the girder is, in pounds:

$$W = \left(\frac{2M_t}{fh} + \tfrac{3}{4} \times 12ht\right) \times 3.4 \times 1.3L = \frac{9M_tL}{fh} + 40htL \quad (1)$$

If no web area is counted as effective flange area, then

$$W = \left(\frac{2M_t}{fh} + 12ht\right) \times 3.4 \times 1.3L = \frac{9M_tL}{fh} + 53htL \quad (2)$$

The thickness of the web is usually required by specifications to be not less than $^1/_{200}$ of the depth of the girder $\left(\frac{12h}{200}\text{, in inches}\right)$ nor, for girders less than 6 ft. deep, less than $\frac{3}{8}$ in. Substituting these values in equations (1) and (2), we have if one-eighth the web is counted:

$$W = \frac{9M_tL}{fh} + 2.4h^2L \quad (3)$$

with a minimum for $\frac{3}{8}$-in. web.

$$W = \frac{9M_tL}{fh} + 15hL \quad (4)$$

If no web area is counted as flange area, we get:

$$W = \frac{9M_tL}{fh} + 3.2h^2L \quad (5)$$

with a minimum for $\frac{3}{8}$-in. web,

$$W = \frac{9M_tL}{fh} + 20hL \quad (6)$$

In the foregoing formula M_t, as previously stated, is the total moment, including that due to the weight of the girder itself, which is not known beforehand. The formulas may be reduced to a form by which the weight of the girder may be determined from the moment due to the superimposed loads (live, impact and dead), not including the weight of the girder. For example, in formula (1) if the maximum moment, neglecting the weight of the girder, be called M, we have:

$$W = \frac{9L}{fh}\left(M + \frac{WL}{8}\right) + 40htL$$

Solving for W and simplifying, we have:

$$W = \frac{9ML + 40h^2tfL}{fh - 1.1L^2}$$

Likewise (2) reduces to

$$W = \frac{9ML + 53h^2tfL}{fh - 1.1L^2}$$

Substituting the proper values for t, or treating (3), (4), (5) and (6) in the same manner, we have for final results, if one-eighth the web is counted:

$$W = \frac{9ML + 2.4fLh^3}{fh - 1.1L^2} \quad (7)$$

with a minimum for $\frac{3}{8}$-in. web,

$$W = \frac{9ML + 15fLh^2}{fh - 1.1L^2} \quad (8)$$

If no web area is counted as flange area, we find:

$$W = \frac{9ML + 3.2fLh^3}{fh - 1.1L^2} \quad (9)$$

with a minimum for $\frac{3}{8}$-in. web,

$$W = \frac{9ML + 20fLh^2}{fh - 1.1L^2} \quad (10)$$

These formulas checked against the estimated weights of girders for widely different spans and loadings gave close results.

For girders of very light flange section (small span and light loading) the average gross flange area will be more than the net center area, the actual flange section being nearly constant throughout. The constants in the formulas may be modified according to the judgment of the estimator to give more accurate results for this case. Thus, the coefficient of ML in the equations may be made 10 instead of 9.

Formulas (3) to (6) will be found to be more convenient for use, as the operator can make a fair enough guess of the weight of the girder to avoid a second approximation by formula.

Approximate Truss Weights

The weight of a riveted truss may be roughly estimated by the following formula. The constants were fixed so as best to suit the estimated weights of a large number of bridge trusses designed for the New York State Barge Canal. The formula gives more accurate results than any general formula the writer has noticed.

Let

W = Total weight of truss, lb.;
L = Span length, ft.;
P = Total load (dead + live + impact) carried by the truss, including the (guessed) weight of the truss;
f = Allowable stress in tension.

Then

$$W = \frac{13PL}{f} + 40L$$

The preceding formula may be reduced to give the weight W in terms of the total superimposed load (live + impact + dead loads), not including the weight of the truss itself. If this superimposed load be called p, then

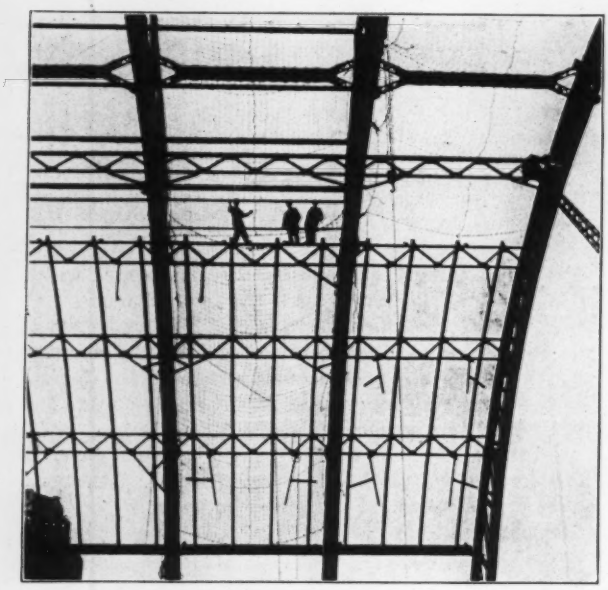
$$W = \frac{13pL}{f} + \frac{13WL}{f} + 40L$$

and, solving for W,

$$W = \frac{13pL + 40Lf}{f - 13L}$$

NOTES

Safety Netting on Steel-Erection Work—In the erection of the steel arch trusses for the recreation building on the Chicago municipal pier, rope nets were used to protect the erectors. During the previous erection of a similar structure a man narrowly escaped death when he fell off one of the trusses, which was struck and shaken by the boom of the erecting derrick. The state factory inspector called the attention of the contractors to the Illinois law requiring protection for men working in such dangerous positions, and on the recreation building the plan finally arrived at was to suspend netting beneath points where the men were working. This arrangement is shown in the accompanying photograph, which represents the removal of the nets after completion of the work. Steel-wire netting was not satisfactory, and the construction adopted was a modification of the rope netting used for the protection of circus performers. The nets are 20x40



NETTING FOR PROTECTION OF STEEL ERECTORS

ft., of ⅝-in. manila rope, with ¾-in. border. The mesh is 6x6 in. The borders are fitted with loops so that the nets can be readily attached to various points and shifted from place to place. When the job is completed, the nets are rolled up for storage or shipment.

State Highway Construction in Washington during the past year cost $1,222,000. With this sum 211 mi. of new state roads were completed and about 100 mi. of old road were straightened, widened and graveled. James Allen is State Highway Engineer of Washington.

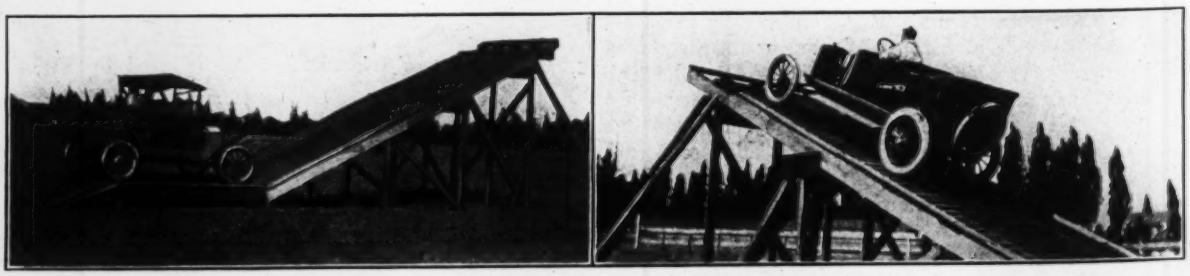
Elm-Tree Roots quite effectively choked 200 ft. of sewer in Concordia, Kan., as the accompanying view shows. The sewer was built in 1903 and was about 20 ft. distant from the trees. The roots almost completely filled the pipe, allowing only a small trickle to flow through. The largest roots were about ¼ in. in diameter. Needless to say, the joints

ELM-TREE ROOTS FROM A SEWER AT CONCORDIA, KAN.

were of very poor mortar. The photograph was taken in 1915, when a new sewerage system was installed by Black & Veatch, consulting engineers, Kansas City, Mo.

Jitney-Bus Traffic in Oakland, Calif., and the neighboring towns bordering San Francisco Bay received a severe setback when an ordinance was passed on Dec. 29, 1915, by the Oakland City Council prohibiting jitney cars from operating within the main business district of the city. The ordinance states that such action is absolutely necessary for the preservation of public safety, and this opinion is reported concurred in by most of the citizens of the trans-bay cities.

A Timber Incline used in demonstrating the hill power, or climbing ability, of a certain make of automobile, was recently built in Santa Rosa, Calif., by the Bailey-Comstock Co., engineers and contractors of that city. Mr. Comstock states that the stand was constructed with a roadway grade of 45° and rose at least 25 ft. from the ground at the highest point. It was heavy enough to withstand the shock of a large five-passenger machine hitting it with a running start and was designed to carry the weight of the machine and the kick from the driving wheels. A trap was built at the top to catch and hold the automobile in case anything went wrong with the clutch or in case the driver lost control while at the top. This trap was constructed by leaving the flooring planks off at the top of the stand and bracing with a heavy timber spiked across the ends of the joist. This opening would catch the front wheels of the car in case of accident. The demonstration consisted of speeding and spring tests, the latter being made by placing 4x4-in. timbers on the track and driving over them at a rate of 15 mi. per hr. There was a cooling test, consisting of a mile run without the fan, and last but not least came the climbing test on the demonstrating stand. From the price for constructing the incline the contractors deducted $5 for the privilege of placing a sign on it during the demonstration.



A STRONG TIMBER INCLINE BUILT FOR AN AUTOMOBILE HILL-CLIMBING DEMONSTRATION IN SANTA ROSA, CALIF.

Editorials

Rating the Qualifications for Success in Engineering

A circular letter has been mailed to all the members of the four great national engineering societies and, in addition, to the Society for the Promotion of Engineering Education, the American Chemical Society and the American Institute of Chemical Engineers, asking for information as to the qualifications that produce success in the engineering profession. The circular letter is signed by Prof. C. R. Mann on behalf of the Carnegie Foundation for the Advancement of Teaching, which is investigating engineering education in coöperation with the joint committee of engineering societies on that subject. The letter follows:

Last spring we consulted you on the subject of engineering education, concerning the qualities that you look for in young engineers and the general effectiveness of the engineering schools in producing such men as you want.

The replies that have been received mention many factors that are essential to the successful engineer. These essential factors fall naturally into the following six groups, which are named in the order of their importance as determined by their frequency of occurrence in the replies:

1. Character—integrity, responsibility, resourcefulness, initiative.
2. Judgment—common sense, scientific attitude, perspective.
3. Efficiency—thoroughness, accuracy, industry.
4. Understanding of men (executive ability).
5. Knowledge of the fundamentals of engineering science.
6. Technique of practice and of business.

If this is a correct definition of the essential characteristics of an engineer, it furnishes the necessary basis for a rational discussion of the effectiveness of the schools. It can also be used as a standard in developing staff organizations and curricula and in selecting efficient methods of instruction.

The best way in which engineers can aid the schools in solving problems in connection with engineering education is by defining the product which they desire. We therefore urge you to contribute to this important cause by numbering the foregoing six groups in the order of importance which you give them in judging the reasons for engineering success and in sizing up young men for employment or for promotion.

Any engineers who have not received this letter and who may be interested to aid in the investigation are invited to send their replies to Professor Mann.

At the recent annual meeting of the American Society of Civil Engineers Professor Mann reported progress in the investigation and read the list of qualifications enumerated and the ratings that have been awarded to them in the replies received from several thousand engineers. The rating was made on a scale of 100 and, according to the average of the ratings as stated by Professor Mann, the percentage assigned to the other grounds of qualities was so high that knowledge of the fundamentals of engineering science as a requirement of success was rated at only 13%.

This statement was greeted with tumultuous applause. When one attempts to analyze it carefully, however, it is perceived how unsafe may be deductions from such investigations as a guide to practical work in engineering education. In hiring young men for subordinate positions in an engineering organization "knowledge of the fundamentals of engineering science" by an applicant is rated by the employer at very much more than 13%.

It seems evident that those who, in answer to the questions sent out by the committee, have stated the qualifications that make for success in engineering have had chiefly in mind the qualifications that enable a man to achieve leadership in his profession rather than the qualifications that enable the average engineer to earn his living at daily routine work.

It is in the application of these indexes to success to the practical problems of technical education that error might most easily occur. Such personal qualifications as character, judgment, efficiency and understanding of men are to a very considerable extent inborn qualities. They may indeed be cultivated and improved or allowed to deteriorate, but they are on a wholly different basis from the knowledge of engineering science, which it must be the primary function of the engineering schools to impart, even though these schools may well at the same time do what they can to develop and improve those personal qualities of the student which are undoubtedly essential to the highest success.

Who Should Design Temporary Subway Timbering?

A chief feature of subway building as carried on so extensively in New York City is the temporary timbering for carrying the street surface and for retaining the slopes where necessary. This construction is not only omnipresent and therefore very extensive and costly, but is frequently intricate and of varied design to fit the special conditions continually and literally unearthed. Under the present manner of contract letting, the contractor designs the timbering, subject to approval by the Public Service Commission. Would it be more equitable to contractors and safer to the "man in the street" for the Public Service Commission to design the temporary timbering prior to the letting of the contract and have it bid on as a part of the contract? In "Secure Subway Supports," read at the regular meeting of the American Society of Civil Engineers on Feb. 16, the authors, A. B. Lueder and W. J. R. Wilson, have the following to say on this important subject:

It would be conducive to greater safety if the main features of the system of support to be used were designed before letting and bid upon as part of the contract. Systems have been designed piecemeal from the bottom up by combining the ideas of timbermen and other workmen, but the writers believe that the safety of city streets would be better guaranteed with a comprehensive design made by competent engineers. The authority and responsibility connected with the design of street supports and the inspection of them when placed or when shifted or removed should be in as few hands as possible.

This, like many questions, has two sides. Many contractors will hold, and perhaps with justice, that such a procedure would be unfair to them. There are many methods of timbering, and each contractor has to a certain extent his own pet system and an organization that is familiar with that particular system. Furthermore, he must select a method that will fit his equipment.

An efficient system of street supports is not one that is merely safe. Even though it were "absolutely safe," it might not be good timbering from the standpoint of economy of money and time, both of which are important elements in work of this size and character. Many of the ingenious designs of subway timbering have been evolved by contractors—or perhaps more properly, by the engineers employed by contractors—under financial stress. These men will claim that if a rigid system is laid down for them to follow, it will be one more obstacle that they must overcome in prosecuting this already difficult and even harrowing work.

Could a comparatively rigid method be followed? Special conditions of soil would make frequent departures from the system necessary. When confronted by unforeseen conditions, the contractor would have to ask permission of the Public Service Commission to use another method. In legitimate cases of this sort he would probably be told to go ahead and use the other method, but at his own risk. Thus the contractor would be responsible for a certain amount of the timbering anyway. This condition would create a division of responsibility, probably with the orthodox result.

Messrs. Lueder and Wilson believe, and rightly, that the systems of temporary supports should be designed by competent engineers. But contractors with organizations big enough to handle subway contracts employ competent engineers. Whether the systems are designed by competent engineers in the employ of the Public Service Commission or of the contractors should make little difference as long as those systems are approved by the commission. Approval by the commission is of course a necessity; although an equally important matter is that there should be continual inspection of the street supports by the commission.

A compromise between the two opinions would be for the commission to include in the specifications one or two alternate systems of supports, giving the contractor the privilege of submitting a design of his own. That it is difficult to estimate the cost of timbering is undeniable, and to have a definite system specified by the commission might be welcomed by some contractors.

A last question: Does the city or the Public Service Commission want to be responsible for the subway timbering?

Typhoid an Accident Under Compensation Law

Holding mill owners responsible for deaths from typhoid fever caused by faulty connections between polluted mill water-supplies and city water-supplies will hasten the day when this grave danger will be greatly reduced, if not quite eliminated. The exact method of pollution in the case mentioned below is not reported, but the usual method is a defect in the design or maintenance of the check valve that is supposed to prevent the polluted mill supply from getting into the city supply, while admitting a flow in the other direction.

The case in point is all the more interesting and important because it holds an employer liable for a typhoid death under a workmen's compensation law. The facts are these: A lumber mill at Eau Claire, Wis., discharged its sewage into the river at such a point as to pollute its boiler water-supply, the pipe for which was also connected with the city water-supply. An employee who drank this polluted water died from typhoid fever on July [illegible], 1914. A suit for damages was brought. On demurrer the Wisconsin Supreme Court decided that such a death was "proximately caused by accident" due "to his employment." (Vennen vs. New Dells Lumber Co., 15[illegible] N. W. Rep., 640, Oct. 26, 1915; also *Public Health Reports*, United States Public Health Service, Feb. 11, 1916.)

The court seems to have upheld the contention that the typhoid was caused by "the undesigned and unexpected occurrence of the presence of bacteria in the drinking water" supplied to the deceased, and that this was an "accident" under the meaning of the Wisconsin compensation law. One dissenting justice held that such an interpretation went far beyond the intent of the legislature, which he maintained had physical injuries, like blows, in mind.

The opinion of the majority seems sound. Why should not a workman's family be compensated for negligence that fills his system with millions of typhoid germs and causes death after a long and painful illness as well as for negligence that strikes him a swiftly fatal blow?

Power Plant for Government Buildings in Washington

A widespread campaign of newspaper publicity has recently been carried on to stop the construction of the new central plant to supply light, heat and power to Government buildings in Washington. It has been alleged that the engineers have so located the structure that it will be a hideous blot in the landscape and a permanent disfigurement of the plan for the beautification of the capital city. The architectural profession and its societies have been especially active in stirring up this opposition and have secured the support of prominent engineers.

Engineering News has taken pains to ascertain the facts concerning the project and the arguments made for and against it. Unimportant though the whole matter is in comparison with the profound events now stirring the world, certain questions of engineering interest are involved, as well as the question of national interest as to whether harm is threatened to the beauty of Washington.

It has long been realized that there would be great advantage if the group of Government buildings in Washington lying between the White House and the Potomac could be furnished with light, power and heat from one central station. The principal advantage to be gained is not the money saving in fuel and operating cost, although a central station does promise a large gain in this respect. Of much greater importance is the removal of the independent power plants now necessary in each of these buildings, thereby making it possible to do away with the hauling of coal and ashes to and from these buildings and, more important still, to put an end to the discharge of smoke, dust and gases from these individual power plants, which results in inevitable soiling and defacement of the building exteriors. This plan further makes it possible to remove the projecting chimneys from these Government buildings.

These obvious advantages of a central light, heat and power station led Congress in 1904 to direct an investigation of the matter by the late Bernard R. Green, then superintendent of the Congressional Library building and

an engineer of eminence who was a leader in many projects for the beautification of Washington.

Mr. Green in his report strongly recommended the construction of such a central plant and suggested three different locations. Nothing further was done about the project for seven years, until in 1911 Secretary of the Treasury McVeagh appointed a committee of three engineers to report plans for such a plant. This committee reported plans for a plant to be built on that one of the three sites recommended by Mr. Green that was most remote from the buildings to be served. A special vote of thanks was passed by President Taft and his cabinet to this committee of engineers for its work.

On June 23, 1913, Congress passed an act to carry out the recommendations of the committee. The Secretary of the Treasury employed the firm of L. B. Stillwell & Co., engineers, of New York, to go over all that had previously been done, recommend any desirable changes and prepare plans and specifications for the work. The contract for the construction of the plant under these specifications was awarded on Dec. 24, 1915, to W. C. Cornell Co., of Washington and New York, and work is now in progress.

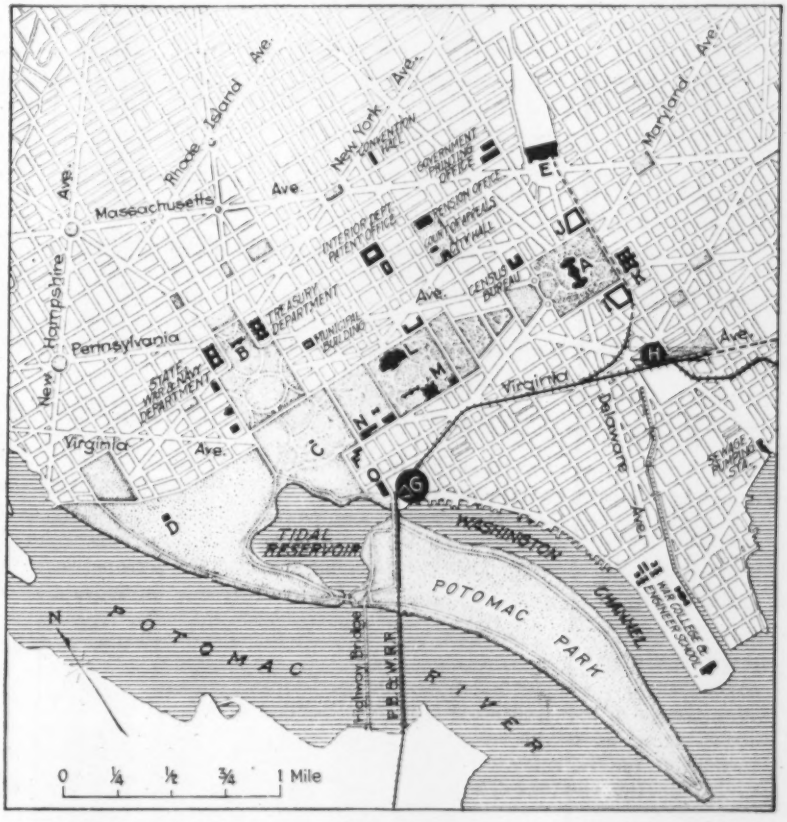
Under an executive order all plans for Government buildings in Washington must be submitted before execution to the Fine Arts Commission. Through an oversight (due to the fact that the detailed plans were prepared by an engineer outside the department) this was not done until after the contract had been awarded. When the plans were submitted, the Fine Arts Commission objected to the location of the plant on the site selected and also suggested various modifications in the design. The advice of the commission was not accepted by Secretary McAdoo, however, and the campaign to stop the work on the plant and open the whole matter anew appears to have been the direct result. The matter has been the subject of long and heated debate in the Senate, and on Feb. 15 a resolution was passed requesting the Secretary of the Treasury "to modify the plans for the work as far as possible, to better harmonize with the Polk Commission plans for the improvement of the commercial waterfront and with the general beauty and comfort of the City of Washington."

The opposition has centered chiefly on the proposed location of the plant, and the statement has been published that the plant is located on the Mall, where it will disfigure the great group of Government buildings planned for that space. The actual location of the plant, however, is on the Potomac River front behind the embankment of the railway approach to the Potomac River bridge. Much of the plant will be hidden from view from the Government buildings it serves and from Pennsylvania Ave. by this embankment. The plant is 1⅛ mi. distant from the White House; and while the tops of the stacks are at an elevation of 175 ft., all but their very tops are hidden from points of view near the White House by the roof of the great building of the Bureau of Engraving and Printing.

The accompanying sketch map of central Washington shows the location of the plant with respect to the principal Government buildings. It will be seen that the plant is located on the commercial waterfront of Washington; the piers for oyster-boat and excursion traffic are immediately adjacent.

In a statement furnished by Secretary McAdoo on Feb. 7 to the chairman of the Senate Committee on Appropriations the secretary urged the advantage of the site as follows:

> The selection of this particular site for the new power house was dictated by the ABC's of mechanical and electrical engineering. It is so placed as to be readily and cheaply served with coal both by rail and by water, and the ashes can be cheaply and readily removed by the same means. Condensing water in large volumes is close by and can be handled with the minimum expense for pumping. The plant is fairly within the center of gravity of its load. It is within 800 ft. of buildings which will take 50% of the steam generated and nearly 40% of the electric current. The plant is located on the commercial waterfront on property owned by the Government, and at the least conspicuous place in Washington for such a plant. Its construction will eliminate 17 existing smoke-stacks on Federal buildings now discharging smoke and gases. The plant will effect an annual saving in the supply to present buildings estimated at $177,000, and a further saving of $85,000 when additional buildings are supplied.



SKETCH MAP, SHOWING LOCATION OF PRINCIPAL GOVERNMENT BUILDINGS IN WASHINGTON AND SITE OF NEW CENTRAL HEATING PLANT

A—Capitol. B—White House. C—Washington Monument. D—Lincoln Memorial. E—Union Railway Station. F—Old Bureau of Engraving and Printing. G—Site of new central heating plant. H—Garfield Park. I—House office building. J—Senate office building. K—Library of Congress. L—New National Museum. M—Old National Museum. N—Department of Agriculture. O—New Bureau of Engraving and Printing

Those who oppose the present plant do not oppose the construction of a central power plant, but argue that a different site should have been selected. They take this position, not so much because of any injury to the view from the White House grounds or the Mall, as because of the park development on the opposite side of the Washington channel and along the river front to the west. They urge that the plant should be built as an addition to the present central power plant in Garfield Park, which supplies the buildings grouped around the Capitol.

The accompanying map will make clear to the reader the location of the two sites and of the principal Government buildings. It must be borne in mind in considering the question of relative location that the use of the plant to distribute steam is the chief factor to be considered. Were it merely a power plant, it could readily be removed to some more remote location; but the practical difficulties in transmitting steam long distances through tunnels under city streets are well known. The distance from Garfield Park to the more remote buildings on the Mall is nearly three miles.

In a resolution approved by the Council of the American Institute of Consulting Engineers opposing the site adopted the following appears:

The construction of a power station, with its towering chimneys, upon this site will be a hideous object in the foreground of the beauties of Washington, upon which the nation is spending many millions of dollars.

It is a fair question to raise, Why should a power station be a "hideous object?" The "towering chimneys" are not essential. It makes only a trifling difference in the operating expense of the station to provide for draft enough so that the chimneys can be lowered to a level with the roof line. The power-station building itself need be as beautiful in its architecture as any other structure. A power station in Frankfort, Germany, with its fine architecture and stained-glass windows, is one of the show features of the city.

In the present condition of Washington's commercial waterfront, with its old wooden buildings, any power station would be an adornment. In the future development planned for that waterfront the power station can be made at least as beautiful as the piers and warehouses.

It has developed as a result of the agitation that the plans for the new power station are inadequate, having been made to fit a limited appropriation instead of planned to meet the actual needs, ornamental as well as economic. A radical revision of these plans would be to the nation's advantage, but a balance of all the arguments thus far presented indicates that no mistake was made in the choice of a site for the plant.

Letters to the Editor

Power Developments Along the New York Barge Canal

Sir—The articles in *Engineering News* of Jan. 20 and 27, on the operation of the New York State Barge Canal, make a few references to factory sites and power developments along this waterway and afford an opportunity of again pointing out how essential it is for the proper operation of the canal that the present legislative restrictions on the sale of canal power be removed with the greatest caution.

When the original Erie Canal was constructed, the canal commissioners granted rights to the use of such surplus water as might be created by the state dams, in exchange for the right to build those dams and utilize the fall in the stream. The canal itself was the best means of transportation then available, and these power sites attracted industries. In these early days 36 to 40 leases were granted, usually in perpetuity with a small annual rental and providing that the state could resume the use of the surplus water for navigation purposes at any time.

Most of these leases were canceled at an early day for nonuse, or nonpayment of rental. The total amount of remuneration that the state obtained through its sales of surplus waters on the Erie Canal for the 75 years down to 1910 inclusive aggregates only $191,572. The Kennedy & Hatch lease at Lockport and the lease now owned by Finch, Pruyn & Co. at the state feeder dam on the Hudson River above Glens Falls are still in force. In the case of both these leases the Supreme Court has recently held, as the writer understands it, that as long as the rental is paid, the state cannot cancel or revoke these leases. If the amount of surplus waters available at these sites is increased, then this additional water may be utilized as surplus water under the original leases without payment of additional rent.

As early as 1826 it was found that the drawing of surplus water from canal levels for power purposes interfered with navigation. Boatmen are wasteful of water on the canals. No matter how abundant the water-supply, the boatmen would succeed in using or wasting it all, if they were permitted. Their object, as a rule, is to facilitate the passage of boats by sluicing them through locks. They prefer to keep the canal levels at their maximum stages by wasting water, rather than to exercise greater care in navigation in order to avoid the possibility of running aground.

The menace to the canals from the draft of surplus waters was a primary cause of the revocation of most of the outstanding leases about 1840 and the refusal of the state canal commissioners to grant further leases. In 1870 a general investigation was made by the canal commissioners. It was reported that the use of surplus water for power was inimical to navigation and that there was no apparent remedy.

For the present, at least, no provision should be made that will allow surplus water power created by the Barge Canal to be used in such a manner as to cause the slightest interference with navigation. Indeed, if the development of surplus power from canal waters is carried out even in its fullest extent subject to this restriction, it will be found, first, that the maximum amount of power available (about 50,000 hp.) is considerably less

t n appears to be the case from estimates based on ideal canal-operating conditions, and, furthermore, that the value of such power is as a rule considerably less than the value of an equal amount of otherwise equivalent power not subject to such uncertainties and restrictions.

There is about half a million horsepower of water power in use within the state at the present time, and an equal or greater amount is or can be obtained from the Niagara and St. Lawrence Rivers. This supply, with the possibility of a large increase in the power obtainable at privately owned power sites as a result of 24-hr. use of existing power and as a result of more efficient development and control of the streams by storage where feasible, makes it evident that the total amount of water power owned by the state is not a controlling factor as regards the market for water power in the state. The removal of the present legislative restriction on the sale of canal power should be deferred until the Barge Canal has been in actual operation long enough so that its operating conditions can be determined and the mistakes of 1826 avoided.

ROBERT E. HORTON,
Consulting Hydraulic Engineer.

57 North Pine Ave., Albany, N. Y., Jan. 30, 1916.

Why a Certain Grouted Brick Pavement Heaved

Sir—In your issue of Jan. 13, 1916, I noticed a letter signed by F. T. Gillett, Engineer Vincennes Traction Co., asking the readers of *Engineering News* if they could explain the failure of a certain grouted brick pavement laid between rails of a street-railway track in Vincennes, Ind. On this job the sand and cement were wet with a hose before the joints were grouted.

This is not a practical method to employ in freezing weather, as water will not run through the material, as it does in warm weather. The frost is given an opportunity to heave up the brick immediately. The rails allow no expansion of the pavement; and no matter how carefully they are spiked or bolted, the weight of cars going over them causes them to wave slightly, which greatly increases the tendency of the brick to hump. I have seen exactly this condition in New York City.

Some years ago I laid a driveway, using the same method that Mr. Gillett employed. This driveway was between two buildings. It was cold weather when the work was done, and within two weeks the pavement had heaved. I never recommend the use of this method in very cold weather.

EDWIN C. BRADLEY.

Graham Manor, West Haven, Conn., Jan. 23, 1916.

Pile Formula Misinterpreted

Sir—I noticed with considerable interest the article entitled "Pile Formula Overruled by Test," in your issue of Jan. 20, 1916. On reading the article I became very much impressed by the injustice meted out to the formula, the name of which was not stated, but which I presumed to be Wellington's, more commonly known as the *Engineering News* formula.

This formula, as everyone knows, gives the safe load immediately after driving. The writer of the article evidently must have overlooked that fact. The tests which he quotes as "overruling" the formula were taken during a period of 14 days, during which time the loads were increased from 5 tons to 35 tons. Previous tests have amply proved the fact that the effect of rest on a pile in certain kinds of material, and especially in a sticky clay such as this happened to be, is to increase the bearing power of the pile. Now, computation by the formula gives a safe load immediately after driving of 4 tons, which was approximately borne out by the test, showing that the formula was not in any way "overruled."

There is so little accurate information in regard to piledriving, because of the many varied conditions encountered, that it seems as though we should be very careful how we attempt to discredit a formula that has been of considerable use, especially when we are so careless as to put a wrong interpretation on such formula.

Ithaca, N. Y., Jan. 29, 1916. C. A. THOMPSON.

Business Methods of Patentees

Sir—When confronted with a demand for royalty on a reinforced-concrete retaining wall in place two years, a city water commission was advised by the writer, who designed the wall, that such a patent had no legal standing. This bears out your statement in *Engineering News*, Feb. 10, 1916, p. 259: "The average engineer is apt to take a snap view of the legality of the Bone patent." The writer's advice was not followed; a majority of the water board, having knowledge of the high cost of lawsuits, decided to pay up. They may have been helped to this decision by the fact that the patentee's demands were comparatively moderate and by sight of a photograph of the $18,000 check made out by the Chicago, Burlington & Quincy Railroad Co.

Whatever view the courts may take ultimately of the legality of the Bone patent, the writer believes that Mr. Bone's business methods do not measure up to present-day ethical standards. In 1908 F. A. Bone, signing himself General Manager of Concrete-Steel Retaining Wall Co., wrote a very instructive article in *Engineering News*, Mar. 26, p. 347, showing a saving of 50% and over by use of an L-shaped instead of a gravity wall. After having aroused in the reader such an appreciation of the L-shaped wall, it would have taken but a few strokes of the pen to mention patent No. 705,732, granted July 29, 1902. But the author's ink gave out, and the interested reader never guessed that this favorable economy must be somewhat reduced by the royalties due the patentee.

Descriptions of patented articles have their place in engineering literature, but the fact that the article is patented should not be left for the reader to guess. Compare the above methods with the article in *Engineering News*, July 2, 1914, on the Wheeler filter bottoms, which concludes with the statement that the patents had been applied for in 1913.

There is another phase of Mr. Bone's business methods—his reluctance to put himself forward until the structure is completed and in use. When the writer was called upon in 1910 to design several hundred feet of reservoir wall, he looked up Mr. Bone's article, made comparative estimates for local conditions and chose Mr. Bone's type. This contract was advertised in *Engineering News* in the fall of 1910, but not until four years later did the patentee come out with his bill for royalties. Innocent of the existence of such a patent, the writer had

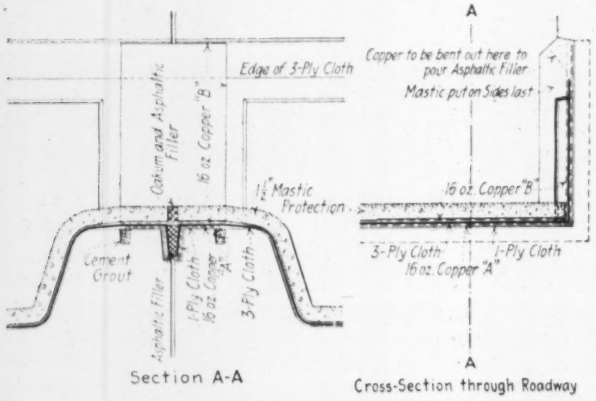
not included cost of royalties in his engineer's estimate. The patentee's demands put the designer in a very uncomfortable position before the lay members of the board of water commissioners; he felt himself under suspicion of stealing the design. This could have been easily avoided, had Mr. Bone started correspondence when the contract was advertised.

If. Mr. Bone's patents are legal, he has no reason for withholding his demands. Even counting in royalties, his type of retaining wall will often be found the most economical. Why does he not modernize his business methods? Then engineers will more cheerfully accede to his demands. BONEHEAD.

Feb. 12, 1916, New York City.

Waterproofing the Lackawanna Railroad's New Viaducts

Sir—My attention has been called to the fact that misleading, or at least incomplete, statements of the facts with reference to the method of waterproofing the Martins Creek and Tunkhannock viaducts, on the new line which the Lackawanna has just built west of Scranton, have been made by a firm advertising its waterproofing materials. Since the writer's name has been used in connection



DETAILS OF WATERPROOFING OF THE TUNKHANNOCK VIADUCT

with some of these advertisements and wholly without authority being given to the advertiser, he feels that it is essential at this time to make a short and concise statement of the facts, so that there need be no further misunderstanding as to the kind of materials used or how the work was done.

Both the structures referred to were treated alike, the same waterproofing materials being used in each case. The only material difference is the fact that the Martins Creek structure is a three-track viaduct, with two separate lines of drain pipes in the floor system, while the Tunkhannock is a two-track structure, with but one line of drain pipes.

The floor system over each main arch is divided into three parts by four transverse expansion joints—two adjacent to each pier and one at each of the quarter points of the span. The floor is drained by downspouts through all spandrel walls, excepting those at the two intermediate expansion joints, and the drainage is discharged into the openings between the two ribs of the main arch. The drainage is prevented from flowing over the expansion joints by dikes built across the floor.

The waterproofing proper was done by using three plies of Minwax saturated cotton fabric laid in Minwax hard waterproofing. The concrete was first mopped with the Minwax hard waterproofing, applied hot. The three layers of cloth were then laid in the usual manner, each layer being mopped before the application of the succeeding layer. This waterproofing was carried up the sides of the parapet wall to the top of the ties and directly across all expansion joints, so that the waterproofing was in reality continuous from one end of the bridge to the other. At the expansion joints one additional layer of the saturated fabric was laid across and folded in the expansion joint beneath a copper flashing, similarly laid, over which the three layers of waterproofing were placed. A fold was provided in the waterproofing at the joints to provide for expansion and the entire joint filled with the Minwax hard waterproofing, poured hot. A detail of this expansion joint is illustrated in the accompanying sketch.

As a protection to the waterproofing the Johns-Manville asphaltic mastic, mixed with torpedo washed gravel, was applied hot in two ¾-in. layers over the entire area of the waterproofing. In order to avoid injury to the waterproofing by the hot mastic, one ply of Johns-Manville asbestos felt was first laid over the entire area of the waterproofing. An opening was left in the mastic directly over the center of each expansion joint. This opening was filled with the Minwax hard waterproofing compound. The Johns-Manville asphaltic mastic was used for protection in preference to brick or concrete, since our experience elsewhere with this mastic, under ballast, indicates that it does not crack and in reality forms a secondary waterproofing surface on which the drainage readily passes to the downspouts. G. J. RAY,

Chief Engineer, D., L. & W. R.R.

Hoboken, N. J., Feb. 24, 1916.

Lime To Correct Acid Sludge in Imhoff Sewage Tanks

Sir—In Doctor Imhoff's article entitled "Eight Years of Imhoff Tank Design and Operation—II," published in *Engineering News*, Jan. 13, 1916, very decided views are expressed by the author on the inadvisability of adding lime to the sludge compartment of an Emscher tank to correct acidity as an aid in obtaining good sludge. As our results in Philadelphia are quite contrary to these ideas, I think it would be of interest to your readers to know our experience, which is as follows:

The Pennypack Creek sewage-works at Philadelphia treat sewage collected from about 4,500 persons, two-thirds of whom are housed in the County Prison, House of Correction and the Home for Indigent. In these institutions breakfast usually consists of bread and coffee; supper of bread and tea, or cocoa; dinner of bread and soup, or meat stew, with occasionally roast meats, vegetables, dried fruits, etc. With this diet it is self-evident that the suspended matter of the sewage would be highly carbonaceous and would contain more than normal amounts of fat in appreciable-sized pieces.

The sludge deposited in the Imhoff tank upon decomposition apparently produces more carbonic and fatty acids than the ammonia produced by the hydrolysis of the nitrogenous bodies can neutralize.

During the early operation of the plant the gas bubbling up through the vent was inodorous and could be ignited, and the sludge withdrawn contained considerable quantities of gas, showing that decomposition was going on in the sludge compartment. But the sludge withdrawn up to last spring was gray in color, sticky and heterogeneous in structure, not free from odor and dried slowly on the sand beds.

An examination of the sludge from one of the tanks showed it to contain 2,200 p.p.m. acid (by phenolphthalein as indicator). Barrels were set up over the vent, with a spigot near the bottom, and lime water added therefrom to the sludge by a pipe extending from above the water level to mid-depth of the sludge.

The lime could not be added at a very uniform rate, owing to clogging of the spigot, but about 10 bu. of lime a month were added to the two tanks, which together receive 1,250,000 gal. of sewage a day.

Each successive withdrawal of sludge thereafter showed less acid content and an improvement in quality, and in the late fall considerable quantities of sludge were removed from each tank to avoid applying sludge to the drying beds during freezing temperatures. This sludge was all of good quality, practically neutral in reaction, black, granular, free flowing, filled with gas, inodorous and quick drying.

As the tanks were put in service in 1912 and no really good sludge obtained until after the application of lime, it is only reasonable to presume that lime was the cause. However, in order to demonstrate whether the addition of the lime tended to weaken the good bacteria, as Doctor Imhoff has suggested, no lime has been added all winter, and it will be of interest to find what character of sludge will be obtained in the spring.

W. L. STEVENSON,
Assistant Engineer, Sewage Disposal.

City Hall, Philadelphia, Feb. 11, 1916.

Ductile Steel for Safety

Sir—The editorial note appearing in *Engineering News*, Jan. 20, 1916, under the caption "Ductile Steel for Safety" calls attention to a subject that cannot be brought too forcibly to the attention of all engineers—particularly of those in responsible charge of specifications for steel and for metal reinforcement.

There is no reason why the steel used to reinforce the tension side of a reinforced-concrete bridge floor-beam or stringer should not be of metal as reliable as the metal in the lower chord of a short-span bridge. The writer knows of an instance where a whole carload of steel supplied for use as metal reinforcement for a concrete-bridge floor was rejected because its elongation was 10% or less. (The specifications required an elongation of 25%.) The plea was made in an effort to have the material accepted, that the use of similar material was "almost universal" and that, if the material was "accepted with a warning," no more similar material would be supplied. The rejection was insisted upon, no further discussion resulted, and no more steel was supplied, for use in concrete-bridge floors, that did not have an elongation of 25%.

Similar action in like circumstances would soon put an end to the "almost universal use" of bars "short" in elongation and therefore lacking in reliability. Contractors are willing to supply any grade; in fact, they prefer the soft steel, because of the greater ease with which it can be handled in the field.

About the best single indicator of steel suitable for bridge members subjected to a wide variation in stress intensity or to shock is its elongation. Steel having an elongation of about 25% and possessing the usually attendant properties is suitable for the lower chord of a short span bridge, the tension side of a slab or beam of a reinforced-concrete bridge floor or for any bridge member subjected to shock or to a wide range of stress.

To one familiar with the treatment of metal reinforcement in the field during the various operations preliminary to the pouring of the concrete, the use of steel of mild grade seems almost imperative. Hard steel is difficult to handle and to bend to prescribed shape; it requires experts to prevent serious injury. The ease with which mild steel can be bent to desired shape is really an index of its capacity to do useful work; that is, mild-steel bars having an elongation of 25% are sometimes deformed with the intention of increasing their efficiency as metal reinforcement. After deformation these bars are found to have an elongation of only 10% and frequently much less. The process of deformation has reduced the potential elongation of the material from 25% to 10%. This loss in potential elongation is an index of the capacity of the metal to give service.

W. H. YATES.

52 Wall St., New York City, Feb. 4, 1916.

Sinking-Fund Delusions

Sir—Permit me to make another effort to indicate clearly my position in regard to one feature of the much misunderstood subject of so-called "depreciation" (cost of periodic renewals of plant)—this in answer to your editorial comments on my letter in your issue of Jan. 27.

In the case cited in my letter, assuming an average life of plant of 40 years, if we require the consumers to pay on the "straight-line" basis, we charge to operating cost each year for 40 years $2.50 for each $100 worth of plant periodically to be renewed. If we require the consumers to pay only on the basis of a 4% sinking fund, we charge to operating cost each year for 40 years only $1.05 for each $100 worth of plant periodically to be renewed. This saving in cost of operating, which presumably will be reflected in the service rate under commission regulation, certainly is not a "trick in words or bookkeeping." It is a very real difference of $1.45 per $100 on all the plant to be periodically renewed.

If the annual charge is made on the "straight-line" basis and this $2.50 per $100 is carried into a sinking fund to accumulate at 4% compound interest, there should be in the fund at the end of 40 years $238.09, or $138.09 in excess of the requisite $100.

If the full $2.50 per $100 per year is put into plant extensions in lieu of isolated investment in a sinking fund, then the earnings on $1.05 of the $2.50 so invested yearly added to the 40 payments of $1.05 will show a total of $100, as required, provided the rate of earnings on these extensions does not fall below an average of 4%. The $1.45 also invested in plant extensions under the same conditions will have created a surplus in form of plant equal to $138.09 for each $100 worth of plant to be renewed, as estimated at the beginning of the 40 years. This surplus in the form of additions to plant will have been paid for from the rates. Here I am not involving

the question as to return on investment, but I am considering the one item of operating cost—namely, maintenance of plant.

It is never to be forgotten that estimates of renewal reserves based upon expected life, involving physical decay or wear, obsolescence and inadequacy, are necessarily liable to error and should therefore be so liberal as to afford full protection to the investment. Furthermore, such estimates should year by year be checked in the light of accumulated experience.

If it is understood that the "straight-line" method is advocated because of this uncertainty as to final cost and is also intended to cover other contingencies and if the assumed "average life" is subject to amendment as indicated, then we have a proposition which is defensible. Let it then be seen that justification of the "straight-line" method on the ground of prudent provision against contingencies is quite different from attempting to justify this larger charge on mathematical grounds or by arguing that the sinking-fund scheme is a "trick in words or bookkeeping."

As to the courts, it is true that their decisions cannot change facts and are supposed only to interpret the laws for the guidance of all concerned. We cannot certainly claim that these interpretations are always correct, for we are constantly obliged to face widely divergent court interpretations on the same law. Even the Knoxville decision, to which you refer, is not in turn given a uniform interpretation by lawyers and courts. As to the inability of the courts to "alter physical facts," it is to be mentioned that some of their opinions and decisions do rest upon an alteration of physical facts. For instance, in one of the most important and far-reaching public-utility decisions of the United States Supreme Court the learned judge who wrote the opinion gave as the chief reason for declaring unconstitutional one feature of the law in question the "fact" that an internal pressure equal to that exerted by a column of water 2½ in. high would burst a cast-iron gas main. So while I am prepared to accord to the courts all proper respect, I also hold that we engineers can instruct the courts as to much that is involved in their "opinions."

This view has *recently* received support at the hands of Judge Prouty, formerly chairman of the Interstate Commerce Commission and now chairman of the Valuation Board, and by Mr. Daniels, a member of the Interstate Commerce Commission.

ALEX. C. HUMPHREYS,
President, Stevens Institute of Technology.

Hoboken, N. J., Jan. 31, 1916.

[Under the conditions assumed by President Humphreys the actual loss of capital through "depreciation"—which we agree it is better to call periodic renewals or retirements—averages $2.50 for each year of the 40. To keep the accounts aligned with the physical facts, President Humphreys should charge to operating cost each year as nearly as possible the actual annual decrement of capital—the annual increment of "depreciation," some still call it. If the straight-line computations are followed, this will be $2.50 in the hypothetical case given. He should also diminish the stated value of the property by the amount so repaid—through changing the ledger value of investment or in some equivalent way. If the operating cost is charged with only $1.05 each year, the difference, say $1.45, must still be recovered from the business in some way. Practically, this is done by holding the stated earning value of the property, or the ledger value, etc., at the original figure—in spite of the capital actually sacrificed. Then the customers pay $1.05 as an acknowledged repayment against depreciation and $1.45 as pseudo-interest, which is really an acknowledged contribution toward depreciation. This is the "trick in words and bookkeeping" that we have referred to. Obviously, if the annual contributions are computed on a direct-repayment basis (like the straight-line scheme), it is not pertinent to discuss their accumulation in a sinking fund or to treat their reinvestment as different from fresh capital.

The attempt of many persons to separate the study of so-called "depreciation" contributions from the consideration of a rate-basis worth in most discussions of rate making, as shown in President Humphreys' letter, constitutes one of the stumbling blocks in the path toward better mutual understanding of all parties concerned. The two matters are so intimately connected, as we have partly indicated, that the full and proper procedure in one direction cannot be scrutinized until it is seen what has been done in the other.—Editor.]

Masonry Reinforced with Metal Nothing New

Sir—The article on the Bone patent, in *Engineering News* of Feb. 10, 1916, has been read with a great deal of interest. The germ of practically all use of reinforcing metal in masonry structures is found in the experimental arch constructed by Sir Isambart Brunel, described in "Civil Engineering," by Henry Law, p. 132, Part II, published in Weale's series, 1869. The advertisement to this book is dated July, 1869. The copy I have has been in my possession since March, 1874.

Under the direction of the late Alfred L. Rives, M. Am. Soc. C. E., the writer made use of the method known as "hoop-iron bond" for strengthening the tension side of brick lintels and slabs, notably in constructing brick-masonry foundation for track scales in the marsh at Mobile, about 1872. The experiment made by Brunel was in 1837-38.

The writer was familiar with the articles in *La Construction Moderne* in 1894 and wondered how it was possible for the Patent Office to grant a patent to Bone at the time it was granted. Another paper, by I. K. Brunel, in the paper of the Institution of Civil Engineers, 1838, p. 20, on "Use of Hoop-Iron Bonding in Brick and Cement Beams," is of interest.

J. G. WALKER.

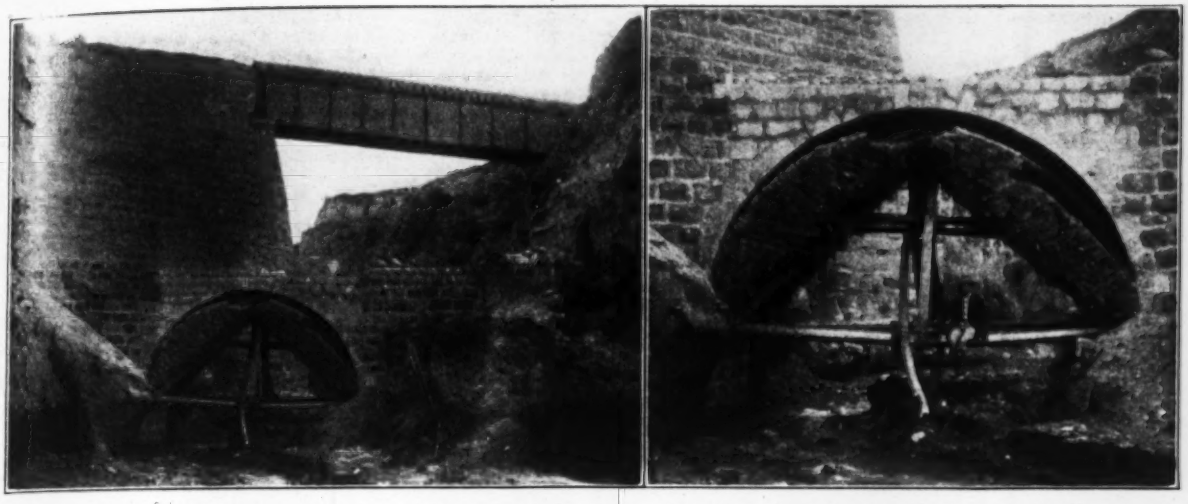
U. S. Engineer Office, Nashville, Tenn., Feb. 12, 1916.

Arch Centers Lagged with Sods

Sir—Herewith are two photographs of a unique method of constructing arch centers, as practiced by Ecuadorian masons in the interior of the country. The arch in question carries an irrigating ditch across a cañon.

The span of the arch is 25 ft.; rise, 12 ft.; thickness at crown, 2 ft.; width, 3½ ft.

As the photograph shows, a triangular framework is first made, using 6-in. diameter timbers of eucalyptus, fastened together by ropes made from split cactus, or maguey, leaves. Then the lagging is formed of sods cut



A 25-FT. ARCH IN ECUADOR; SOD-LAGGED CENTERS STRUCK AUTOMATICALLY BY SHRINKAGE

from the fields. The sods, called *chamba,* consist of the roots of wild grass and earth. They are 6 in. thick by 2 ft. long and 1 ft. wide, are packed on the triangular framework and shaped to the curve of the arch ring. After the arch is built, the sods are left until they dry out and shrink, when they are easily removed.

The photograph was taken two weeks after the arch was built and just before the centering was removed.

H. F. Howe,
Chief Engineer, Guayaquil & Quito Ry. Co.
Guayaquil, Ecuador, Dec. 10, 1915.

Water-Gas Tar for Treating Wood-Paving Blocks

Sir—As interest in the subject of specifications for creosoted wood blocks is at present so great, the article appearing on page 204 in the Feb. 3 issue of *Engineering News* will no doubt be read very generally. It is therefore regrettable that Dr. Von Schrenk's admirable paper should not have been printed in full.

To the casual reader it would appear from the opening paragraph that radical changes in the specifications for creosoted wood-block pavements had received indorsement at the meeting of the American Society of Municipal Improvements held in Dayton, Ohio, Oct. 12 to 14, 1915, but such was not the case. While it is true that the subcommittee did adopt a specification that contained some radical changes from those formerly existing in that society, these radical changes were not accepted by the general committee. The general committee's report to the society recommended that action be deferred until the 1916 meeting, so that all interested might have sufficient time to give their views upon this important subject and thus enable the subcommittee to draft a specification more acceptable to all parties concerned.

We are not able to judge from the data given in the short résumé of Dr. Von Schrenk's paper whether the use of refined water-gas tar as a preservative material is condemned or not. We are inclined to the former conclusion, however, as the only definite reference to the examination of wood blocks treated with that material indicates a failure. Quoting the words of the article, "The failure of blocks in a pavement in Charleston, S. C., was traced to the use of a straight water-gas oil and very poorly penetrated blocks." This appears to the writer as an unjust condemnation, when it is acknowledged by Dr. Von Schrenk that "poor penetration, particularly of the sapwood," is a primary cause of failure.

It is regrettable that such an extensive and painstaking investigation of this subject as Dr. Von Schrenk undoubtedly made did not include a greater yardage of blocks treated with water-gas tar, as millions of such blocks have been laid in the past nine years, to the writer's knowledge, and not a single instance of failure attributable to the preservative used has been reported.

An article by Henry Welles Durham, formerly Chief Engineer, Bureau of Highways, Borough of Manhattan, New York City, appeared in *Engineering News,* Dec. 30, 1915. It gave some very definite observations of a recent examination of test pavements laid on Second Ave., New York City, with creosoted wood blocks that were treated with varying quantities of different types of preservative oils, including two sections treated with water-gas tar—one with 16-lb. treatment, the other with 20-lb. treatment.

Two significant statements are contained in this report: "No difference in appearance is noticeable between the differently treated sections except in extremely hot weather, when there is a slight evidence of oil on the surface of the blocks treated with light oil, but bleeding has practically stopped"; and "Nothing in the present appearance of any of these stretches of pavement indicates that under ordinary conditions any variation of treatment of the blocks had been employed."

Quoting again from the résumé of Dr. Von Schrenk's paper, we find the statement, "The criterion to be used in specifying the preservative ought to be only availability and cost." Under such a criterion water-gas tar would certainly be placed first; and owing to its long and favorable performance, serious consideration should be accorded water-gas tar and a competent specification for it included in all general specifications for wood-block preservative oils.

J. S. Miller, Jr.,
Assistant Chemist, Barber Asphalt Paving Co.
Maurer, N. J., Feb. 9, 1916.

Safe-Stairway Specifications

The number of casualties that occur to persons slipping on stairways is surprising to anyone who has not studied the statistics. In a paper by H. W. Mowery, just published by the American Museum of Safety, New York City, it is stated that there were last year in the single Borough of Manhattan 170 deaths from falls on stairs and sidewalks. During the same period the total deaths from fires were 65, from surface cars 53 and from subway and elevated cars 24. The total of 142 deaths from these four agencies, commonly supposed to involve such danger to human life, was thus considerably less than the number of deaths due to falling on stairs and sidewalks.

The lesson Mr. Mowery draws from these statistics is that it is well worth while for the engineer responsible for the design and construction of stairways to specify nonslipping treads, to properly proportion the treads and risers and to use materials that will not produce a glazed and slippery surface. One can see on the sidewalks of every city and in stores, public buildings, etc., a multitude of cases where these simple precautions have been neglected.

Many of the common errors of construction that occur even when an attempt is made to secure safety are mentioned in Mr. Mowery's paper. A specially noteworthy one is the common practice of covering stair treads with grooves filled with some anti-slip composition running parallel to the treads. In descending such stairs it is difficult in certain lights to distinguish the edge of the step from the grooves parallel with it. It is just as easy to make the grooves for the anti-slip composition run diagonally with the top of the step and thereby save many dangerous falls.

At the close of his paper Mr. Mowery presents the report of a committee of engineers of the Pennsylvania R.R. appointed by S. C. Long, General Manager, to recommend specifications for safe stairways. This report is as follows:

For stairways used by the traveling public the sum of two risers and one tread shall be between 25 and 26 in. No tread shall exceed 13 in. or be less than 12 in., and no riser shall be more than 6¾ in. nor less than 6 in. No corrugated nor ribbed tread over ⅛ in. in depth shall be used on any stair. Noncorrugated, anti-slip treads of lead and aluminum or carborundum, iron and alundum or carborundum, or concrete and alundum or carborundum are recommended for any width of not less than 8 in. on tread, including nosing. Nosings having a projection not exceeding 1 in. are recommended for use on treads. All measurements are to be from top to top of treads and face to face of risers. All stairways to have handrails at each side. Top of handrail to be 3 ft. above top of tread, measured vertically at nosing. All stairways requiring more than 16 risers should have a landing 4 ft. wide, and in general, the single flights should be kept down to 10 or 12 risers where possible. The height of risers and width of treads for stairways used by the traveling public shall be the same for all such stairways throughout in any one building.

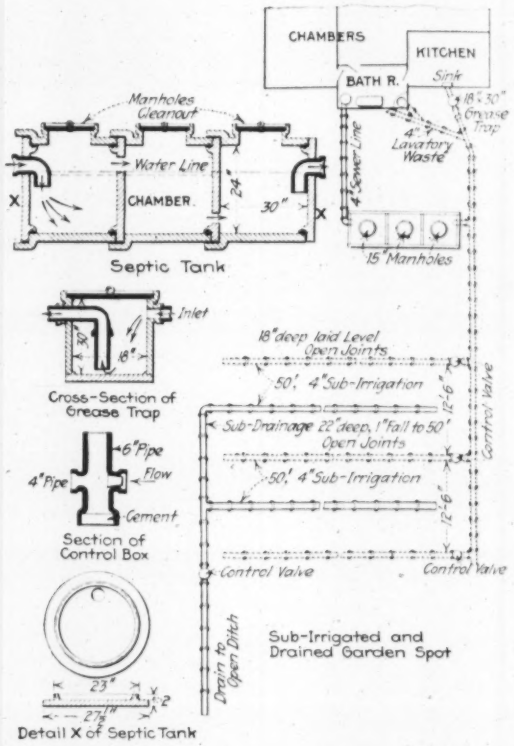
For stairways in office buildings and in places used jointly by employees and the general public the sum of two risers and one tread shall be between 24 and 25 in. No riser to exceed 8 in. or less than 7 in. No tread to exceed 11 in. or be less than 10 in. All stairways to have handrails at sides. Top of handrail to be 3 ft. above top of tread measured vertically at nosing. Noncorrugated, anti-slip treads of lead and alundum or carborundum, iron and alundum or carborundum, or concrete and alundum or carborundum are recommended for a width of not less than 8 in. on tread, including nosing. All stairways requiring more than 18 risers should have a landing 4 ft. wide, and in general, the single flights should be kept down to 10 or 12 risers where possible. The height of risers and width of treads for stairways in office buildings and in places used jointly by employees and the general public shall be the same for all such stairways throughout in any one building.

For stairways in signal towers, shops and places used by employees, but not for the use of the public, the above rules for stairways in office buildings and places used jointly by employees and the general public shall obtain, with the exception that the width of tread shall be not less than 9 in. or more than 11 in.

Single-House Sewage Disposal Plant, Lewisville, Ark.

A vitrified-clay septic tank and sub-irrigation tiles beneath a drained garden are used for the treatment of the sewage from the residence of J. B. Burton, of Lewisville, Ark. The layout and details of the plant are shown by the accompanying illustration.

The septic tank is in three sections, or chambers, each with an estimated daily capacity of 50 gal. The kitchen and bathroom wastes do not pass through the septic tank,



SEPTIC TANK AND SUB-IRRIGATION SYSTEM FOR HOUSE AT LEWISVILLE, ARK.

but go directly to the sub-irrigation system. There is a grease trap on the kitchen-sink outlet. The branch tile distributors and also the underdrain are provided with "control valves."

The septic tank shown was patented Apr. 8, 1913. It is called the adjustable-capacity septic tank (abbreviated to "Adj-Cap" as a trade name), because the number of sections, or chambers, may be increased to correspond with the volume of sewage to be treated. Thus in a plant installed for the Texas State Tuberculosis Colony No. 1, at Carlsbad, Tex., a 60-section tank of this type is in use.

The system of sewage treatment here described was installed under the supervision of the Texarkana Pipe Works, of Texarkana, Ark.

News of the Engineering World

New York Military-Engineering Courses Grow

The second and third lectures in the course on elementary military engineering arranged by the New York engineering societies were held on Feb. 21 and 28. To accommodate all who desire to attend, one series has been arranged for Mondays at 5:30 p.m. and two for 8 p.m.; one of the evening lectures is held in the house of the American Society of Civil Engineers and the other meetings are in the Engineering Societies' Building.

The lectures on Feb. 21 were broken into by a number of speakers seeking recruits for the Plattsburg training camps held by the United States Army. The great interest shown by the New York engineers has led to plans for weekly drills. Two of the city armories will be opened and instruction furnished in March, April and May, under officers of the state militia, on squad and company work, close and extended order, guard duty, target practice, use of arms, packing, etc. It is aimed to give such a preliminary course as will allow more time at the Plattsburg army camp for practice with engineer troops.

Maj. Gen. Leonard Wood, commanding the Department of the East, U. S. A., in an address at the third lecture outlined the system desired by the army in the development of reserve troops. He cited the experience in the wars of the Revolution, 1812 and 1863 as showing that the volunteer system has never been a success. The state militia was described as a weak arm in spite of good men and officers, because of poor equipment, small units, lack of Federal control and the necessity of converting from state to Federal system in event of war. He advocated complete federalization of the state militias and general military service for boys, on the Swiss or Australian plan.

The lecture on Feb. 21, by Capt. R. T. Coiner, Corps of Engineers, U. S. A., was on reconnaissance and the allied topics of surveying and mapping. Great dependence has come to be placed by commanders on maps, since battle fronts have extended far beyond the observation of one man. Many features not seen on ordinary maps are required—character, size and grades of roads and dimensions of bridges; railways, telephone and telegraph lines; canals, rivers and lakes, with data on currents, banks and fords; complete topography, with all obstacles like fences, walls and hedges; street plans of towns, grazing areas, water-supply facilities, etc.

In America all military maps are made to uniform scales of 1, 3, 6 or 12 in. to the mile. Main courses are laid out by magnetic bearings and backsights; distances are taken by pacing, time of horse travel, or revolutions of a wheel; side shots are estimated. In action, maps are made by and behind the advance cavalry screen of a large army. Road maps come first, giving main-column routes and parallel roads. Work of individual sketchers is tied together later by rough triangulation. If there is time, tracings are made; if no time is available, the field papers are inked and prints taken direct. Blueprints are preferred, with brown next in favor. Brownprints with white background are the most useful; bromide papers are used for night printing. Each engineer battalion carries a reconnoissance surveying outfit, a lithographing press and a hektograph.

The third of the regular lectures was by Capt. T. M. Robins, Corps of Engineers, U. S. A., and dealt largely with field fortifications. The requirements of cover were given as 3 ft. of earth for light fire, 12 ft. against field artillery and 30 ft. or more for heavy artillery. The construction of rifle trenches, saps, communicating and supporting trenches of all degrees of completeness was described and their function explained, largely as laid down in the Corps of Engineers' Field Manual and other publications of the army. It was shown how most of this work is done by the line troops, and the special functions of the engineers were outlined. For the simpler intrenchments the line troops now all carry special small shovels and picks, but the engineer battalions are well equipped with real tools—shovels, pick mattocks, bars, saws, sandbags, spikes, etc. A large amount of accessory trench equipment has to be provided by the engineers—drains, sumps, water supply, guide signs, lamps, and all the various obstacles in front. The work of engineers in demolition, largely involving the use of explosives, was explained; the growing use of trinitrotoluol as a substitute for dynamite, etc., was mentioned.

More Water for New York

A 250,000,000-gal. per day addition to the Catskill water-supply of like amount, already developed by the Board of Water-Supply of New York City, has been approved by the Board of Estimate, and the plans for the project will soon go to the State Conservation Commission for its approval. A court action to stop the project was started, but was almost immediately dismissed. The estimated cost of the Schoharie addition is $22,000,000, and the time required for the construction has been estimated as 8 years.

The Ashokan reservoir, formed by the Olive Bridge dam across Esopus Creek, impounds water from a drainage area of 257 sq.mi. The Schoharie drainage area, north of the Esopus gathering ground, covers 314 sq.mi. Still other drainage areas are included in an ultimate water-supply scheme involving a total watershed of 914 sq.mi., which it is estimated will yield 760,000,000 gal. a day through a series of extraordinarily dry years, if sufficient storage is provided. The Catskill aqueduct, leading from the Ashokan reservoir to New York City, has a daily capacity of 500,000,000 gal.

To make the Schoharie supply available, a dam will be built at Gilboa and a tunnel 16⅔ mi. long driven from the reservoir thus formed, to discharge into the Ashokan reservoir.

J. Waldo Smith is engineer, and Alfred D. Flinn is deputy chief engineer of the Board of Water-Supply.

Argentine Business Conditions

Engineering News receives frequent inquiries as to the possibilities of engineering work in South America, from engineers who are desirous of seeking opportunities there. The following extract from a letter written by a well-known American engineer, who is at present connected with the Buenos Aires office of a United States export company, is instructive:

It may interest you to learn something of the present construction situation in this country. The Government, whose revenues are mainly derived from duties on imports, which are of course greatly curtailed on account of the war, is having a great deal of difficulty in meeting its ordinary expenses, and public works are practically at a standstill. The large port works being constructed by the well-known English firm C. H. Walker & Co. have been stopped completely. Payment for this work was being made in bonds; and as the market for these has become extremely limited, Walker was unable to carry on the work. The situation in regard to the irrigation works in Rio Negro, under construction by the Southern Ry., and those under construction by the Central Argentine Ry. is similar, and they have been, or will be, stopped for the same reasons. There are rumors that American interests may take up these works, but as yet nothing has come out of this.

A few small irrigation projects built by the Government itself are still underway, but water-works and so on are quite dead. The large post-office building remains in the condition in which it was one year ago. The steelwork, amounting to 6,000 tons, has been erected and since then repainted several times, but nothing else has been done. This building, located near the port, may be seen from miles out in the channel leading to the city and is a mute evidence to every traveler of the embarrassed position in which the war has placed this country. Until ocean freight rates become more normal and material can arrive in greater volume and until better prices may be obtained for the products of the country, business will be dull.

Bridge and building work is at a standstill. The railroads are doing almost nothing, and many good-sized buildings that were in construction in Buenos Aires at the beginning of the war have remained in the state in which they were left at that time. Exposed steelwork is rusting away, and brick walls are in danger of falling, on account of mortar washing out. About a month ago a 15-story reinforced-concrete building, the lower portion of which runs through from one street to another, forming a handsome arcade, was opened to the public with many ceremonies, but this work was in hand for a long time before the war commenced. A few other buildings, such as the Stock Exchange, are approaching completion. A contract has been signed to construct about 60 mi. of narrow-gage railroad connecting the northernmost town in Argentina—La Quiaca—with Tupiza in Bolivia, but I doubt whether it will be pushed very actively.

Wisconsin Engineers Meet

The eighth annual meeting of the Engineering Society of Wisconsin was marked by active and prolonged discussion of the relations of engineers and contractors and the respective merits of closed and open specifications for paving. The meeting was held in the Engineering Building of the University of Wisconsin, at Madison, Wis., on Feb. 25 and 26.

J. C. Pinney, Superintendent of Bridges and Buildings at Milwaukee, urged that the engineer should give the contractor full information, through the plans and specifications, as to the work required. Otherwise, the contractor cannot intelligently estimate the cost. If "clean" sand is specified, the contractor may figure on using a local sand containing 5 or 6% of loam and find later that the engineer will not allow more than 2 or 3%.

That the engineer should not act as arbiter between client and contractor was the position taken by Prof. D. W. Mead, Madison, and F. G. Simmons, Director of Public Works at Milwaukee. The latter stated that, with full intent to be impartial, the engineer will naturally and involuntarily give greater weight to the interests of his client. In reply to a suggestion that a contractor should not be required to guarantee work for more than one year, he remarked that the purpose of the guarantee is to provide against defective materials and workmanship and that one year is not always sufficient to develop such conditions.

One great difficulty, according to Mr. Simmons, is the tendency to severe competition between contractors. Although prices for materials are higher than a year ago, many recent bids are 6 to 7% lower. For one large job the contractor admitted that he allowed only 5% for profit, which is unreasonably low; and under such conditions the engineer must expect trouble in getting work done to his satisfaction. Mr. Mead also urged that specifications should be fair to both parties and not put all responsibility on the contractor and all authority upon the engineer.

Open Specifications for Paving

A paper on the satisfactory experience with open specifications for asphalt paving, by H. W. Adams, Mayor of Beloit, Wis., precipitated a brisk and protracted discussion. When the city planned large contracts for paving in 1915, strong representations were made that a certain material was so superior in quality that it could not compete in price with others and that the city could well afford to use this material in spite of its higher price. Instead of this, open specifications were employed, requiring the materials to meet tests as to quality. The lowest bids proved to be for the material for which a high price had been claimed to be necessary. Mr. Adams considered the use of open specifications as good public policy, while it tends to avoid excessively high bids and any tendency toward graft.

That open specifications are not advisable or economical for small towns which have no municipal chemist or laboratory was the view taken by P. H. Connolly, city engineer of Racine; that they are undesirable for large cities, especially in admitting various grades of asphalt into competition, was the attitude of F. G. Simmons, Director of Public Works of Milwaukee, in a lengthy discussion strongly favoring a particular grade of asphalt.

The discussion then turned on the law requiring bids to be asked for different kinds of paving on any job, the property-owners then having an opportunity to select which they prefer. A few speakers favored this as conducing to competition, but the weight of opinion was strongly opposed to such a haphazard method of selection, which may tend to cheapness, but not to economy or efficiency. The paving should be selected by authority competent to determine what is best suited to the conditions.

Other Subjects and Proceedings

Bituminous paving was dealt with in two papers. One was on asphaltic concrete pavement, by W. F. Reichardt, consulting engineer, Watertown, Wis. In the discussion Prof. L. S. Smith exhibited samples, including one from a bituminous concrete laid in Washington in 1873. The other paper was on the surface treatment of old macadam paving, by T. R. Valk, Chicago. He advocated cleaning the old surface, applying a bituminous coating and covering this with a layer of stone chips. Care must be taken to clean the surface thoroughly.

A paper on "State Inspection of Public Utilities" was read by C. M. Larsen, Chief Engineer of the Wisconsin Railroad Commission, and the Wisconsin building code was discussed by S. J. Williams, State Inspector. At the annual dinner Prof. D. W. Mead gave an illustrated address on the Dayton flood and the proposed flood-protection works.

Iowa Engineers Talk Ethics

Coöperation, legislation, commercialism and ethics in relation to engineers and engineering were the predominating subjects at the twenty-eighth annual meeting of the Iowa Engineering Society, held at Des Moines, Feb. 16 to 18. This line of discussion was opened with an address by Prof. F. H. Newell, University of Illinois, on the needs and advantages of coöperation in the advancement of the profession to a position where it receives proper public appreciation and recognition. Dean W. G. Raymond, of the State University of Iowa, described the organization of the new Association of Engineers, whose aims are avowedly commercial. Some of its features did not meet with his approval, and he questioned whether the real interests of the profession would be advanced by such a movement.

On the other hand, the report of a Committee on Professional Ethics and Standard Fees, presented by K. C. Gaynor, Sioux City, Iowa, expressed the view that the organization of the association mentioned indicated appreciation of the fact that engineers as a class are wage earners and must organize to obtain suitable pay and recognition. It was shown in the discussion that many engineers on important work in Iowa are paid by the day at rates about the same as those paid for skilled labor. At the annual dinner the principal address was on "Engineering Ethics," by Hon. George Cosson, State Attorney General.

The Committee on Legislation approved a bill for the licensing of engineers, but opposed an architects' licensing bill drawn on the lines that have proved so objectionable in Illinois. A move is now being made to secure the coöperation of the Iowa chapter of the American Institute of Architects in preparing a bill for the licensing of both professions. The chairman spoke of the difficulty of getting engineers to attend the legislative meetings. After setting forth to the legislative committee that he represented the opinions of a large body of engineers, it was discouraging to be able to show only three engineers present to support his position.

Sanitary matters received a good share of attention in the more strictly technical subjects. In a paper on "Infiltration of Ground Water into Sewers," C. P. Chase, Clinton, Iowa, stated that it was almost impracticable to make sewers absolutely tight. It is difficult to guarantee a leakage of less than 10,000 gal. per mi. in ordinary soil or 20,000 gal. in water-bearing sand. Where water can get in, of course sewage can leak out. Mr. Chase also reported for a committee appointed to confer with the State Board of Health in regard to the form of plans and specifications submitted for water-works, sewers and sewage-disposal plants. The forms recommended have been approved by the board; but as they have not been formally adopted, the plans actually submitted for approval "come in every conceivable shape and drawn on everything from butchers' paper to bristol board."

The care and operation of sewage-disposal plants in Iowa was discussed by Dean Marston, Iowa State College, who stated that many such plants are so badly neglected as to be wholly or partly out of service. Many plants are built too small, owing to inadequate resources, but he suggested that engineers can help to remedy this by refusing to design filters for excessive rates of flow. The State Board of Health should refuse to approve plans calling for such rates. He considered that a city council should place entire charge of the plant in the hands of a competent superintendent, preferably the city engineer.

Dean Marston stated also that the Cameron septic-tank patents are again being made the basis of demands for royalties in Iowa, in spite of the fact that the suit against Knoxville, Iowa, was decided in favor of the city by the United States Supreme Court. For this reason a new Septic Process Protective League is being organized by the League of Iowa Municipalities, to obtain the legal aid of the attorney general.

In regard to road and street matters a report on roads and pavements was presented by C. H. Young, of Muscatine; the relation of subgrade construction to cracks in concrete paving was discussed by A. H. Gilliland, Indianola, and a paper on bituminous pavement was read by M. L. Patzig, Des Moines. An interesting paper on "A Comparision of Iowa Paving Law Assessments," by C. A. Roby, Waterloo, showed the variations in assessments under identical conditions in different cities. One session also was set aside for a joint meeting with local good-roads associations.

Among other papers were "Railway Signaling," by G. H. Kilpatrick, Waterloo, and "The Old and New Turbines of the Hydro-Electric Plant of the State University," by R. E. Hutchins, Iowa City. The boiler code of the American Society of Mechanical Engineers was reviewed by S. M. Woodward, Iowa City, and the society adopted a resolution advocating its general use. Prof. A. H. Ford, State University of Iowa, described the nitrogen-filled incandescent lamp for street lighting. In speaking of the advantage of this lamp C. P. Chase, Clinton, stated it had taken the manufacturers six months to devise a bug-proof lamp suitable for cities along the Mississippi River, where vast quantities of bugs and flying insects constitute a serious problem in the street-lighting scheme.

The society elected the following: President, M. G. Hall, consulting engineer, Centerville, Iowa; vice-president, C. H. Young, City Engineer, Muscatine, Iowa; secretary, J. H. Dunlap, Iowa City, Iowa.

A Sewage-Disposal System for Los Angeles County, California, has been proposed as a result of agitation against the joint sewage-disposal project for Pasadena, South Pasadena, and Alhambra. The Board of Supervisors of Los Angeles County voted on Jan. 12 to appoint a commission of five engineers to report on the subject.

Electrification of Railway Terminals at St. Paul and Minneapolis has been proposed by H. M. Byllesby, of the Minneapolis General Electric Co., who has presented plans for the work to President Louis W. Hill, of the Great Northern Ry., and his assistant, Ralph Budd. The project is under consideration in connection with the construction of the new union station at St. Paul.

A Strike of Anthracite Miners may take place on Apr. 1 when the present contract between the anthracite operators and the miners expires. The miners have presented to the operators a series of demands which include an increase of 20% on all wage rates paid in the anthracite coal field, an 8-hr. day for all day labor, time and a half for overtime and double time for Sundays and holidays. Further demands are

recognition of the United Mine Workers and an agreement that all coal shall be weighed and paid for on a run-of-mine basis with no deductions for dirt and rock in the coal.

Extra Pay for Lock-Gate Work—Washington reports say that the claim for $2,394,480 or more of extra pay by the McClintic-Marshall Construction Co., Pittsburgh, is likely to be one-third successful. The claim was referred by vote of Congress to Governor Goethals for report. It is now said that Governor Goethals has reported his recommendation that the company be paid about $714,000. The claim was for additional work required in producing the extra-high grade of workmanship demanded by the inspectors, which the company said was far ahead of that called for by the specifications or by the requirements of the case. The original claim was reviewed in "Engineering News," Apr. 9, 1914, p. 806.

An Inland Waterway along the New Jersey coast extends from Cold Spring Inlet, near Cape May, to the northerly end of Barnegat Bay, near Bay Head, about 114 mi. The waterway has a minimum depth of 6 ft., a bottom width of 100 ft. and is 98% completed. It is under control of the Board of Commerce and Navigation of New Jersey, of which B. F. Cresson, Jr., is Chief Engineer. In the construction of this waterway more than 3,000,000 cu.yd. of material has been excavated, and the outlay for dredging has been $318,251. For the extension of this waterway northward a contract has been let for the first section of a canal to extend from Bay Head to the Manasquan River.

A Conference on drainage and related subjects will be held at the University of Illinois under the auspices of the department of civil engineering, Mar. 8 to 11, 1916. Land reclamation, flood protection, levee construction and the importance of such work to the agricultural interests of the state are subjects which will be discussed by engineers and contractors who have specialized in such work. The practicability will be considered of having an annual short course in drainage engineering under the direction of Prof. F. H. Newell, head of the department of civil engineering and formerly director of the United States Reclamation Service. All who are interested in the subjects mentioned are cordially invited to attend. The department of civil engineering, Urbana, will send full information on request.

Cast-Iron and Steel Water Pipe were in competition at St. Louis, Mo., on Feb. 25, when the Water Department received bids for supplying 27,000 ft. of 36-in. pipe. The East Jersey Pipe Co., New York City, bid $193,680 for lock-bar riveted steel pipe, coated with mineral rubber and wrapped with burlap. The United States Cast Iron and Foundry Co., Philadelphia, bid $207,648, or about $28.80 per ton, on cast-iron pipe. In addition, there is about $17,000 worth of special castings to be added to the bid on cast-iron, which was practically all included in the bid on steel. Bids were also received on laying each class of pipe, and a canvass of all the propositions indicates that cast-iron in place will cost about $35,600 more than the steel. The president of the Board of Public Service has not yet decided which material will be adopted.

A Banquet in the Mill Creek Sewer was held in St. Louis on Feb. 19, in honor of Mayor Kiel and to celebrate the practical completion of the Mill Creek tunnel. The hosts were the contractors—the Carter Construction Co., and Norton, Head & Dineen. The banquet was one of the most elaborate and spectacular ever given in connection with construction work and it is estimated by the local press to have cost $5,000, of which more than $2,000 was spent in transforming this section of the tunnel into a banquet hall. About 200 ft. of the tunnel adjacent to one of the shafts was bulkheaded off for the occasion; a special wood floor was laid and covered with tar paper and tarpaulin. A large ventilating fan was installed in the bulkhead, and toilets and wash basins were provided. The concrete work was painted white, and a large number of electric lights was installed, while steam was piped into the shaft for steam radiators, and gas for cooking ranges.

Ontario Municipal Tramways—The annual convention of the Ontario Hydro-Electric Railway Association was held at Toronto on Feb. 16, practically all the important municipalities in the province being represented. Resolutions were adopted calling upon the government to restrict the export of power to the United States, to prevent the existing power companies from increasing their capital for the purpose of making extensions to their plants, urging the dominion and provincial governments to grant subsidies to the municipalities to aid in the construction of the projected radial lines and asking the Ontario Government to pass legislation authorizing the Hydro-Electric Commission to proceed with surveys and acquire rights-of-way for the hydro-radial railways. Both governments were asked not to grant new franchises or powers for railway construction to any private interests. Sir Adam Beck, chairman of the Hydro-Electric Commission, reviewed the work of that body and [illegible] that the proposed hydro-radial lines would be a profitable proposition from the outset. He considered it essential that the Chippewa development should proceed simultaneously with the construction of the radial lines. The following officers were elected: Honorary president, Sir Adam Beck; honorary vice-presidents, Hon. I. B. Lucas and W. K. McNaught; president, J. W. Lyon (Guelph); vice-presidents, Mayor Thomas Church (Toronto), A. F. Wilson (Markham), Mayor H. R. Stevenson (London), Mayor J. J. Duffus (Peterboro), Mayor W. F. Walters (Hamilton), J. B. Ryan (Guelph) and H. Clay (Windsor); secretary, T. J. Hannigan (Guelph); treasurer, G. P. Hamilton (Guelph).

To Make Soil-Pressure Tests—Experiments on the distribution of pressures through soils are to be conducted at the Government farm near Washington by the Office of Public Roads and Rural Engineering, United States Department of Agriculture. A specially designed apparatus will be installed which will permit earth-pressure measurements being taken in a large number of positions during a single application of the load. This feature is regarded as an important one, and it is hoped that an unnatural rearrangement of the soil from previous load applications in various positions will be thus avoided. Earth-fills up to 10 ft. thick may be accommodated by this apparatus, and it will have lateral dimensions sufficiently large to permit obtaining the full distribution of the load in all directions. Very comprehensve plans have been made for a practical solution of this problem, and it is hoped that definite results will be forthcoming within a short time. The uncertainty of the distribution of pressures through soils, both vertically and horizontally, has long been recognized by the engineering profession, and several isolated experiments have been made with laboratory apparatus to gain knowledge on this subject. In magnitude the problem is such that its practical solution can be attempted only by the most thoroughly equipped experiment stations. In application the final solution will be important to all branches of engineering, and it has seemed desirable that the department should devote a part of its experimental resources to a most thorough and conclusive research of this nature.—Circular of Department of Agriculture.

Sewerage Improvenemts at Nashville, Tenn., are recommended in a report submitted to the City Commission by James Cameron, an accountant of New York City, and H. M. Brinckerhoff, acting for Barclay, Parsons & Klapp, consulting engineers, New York City. The report deals with the Health Department at Nashville and is a part of the general survey of the affairs of that city being conducted by the men named. The report states that the present sewerage system has a large preponderance of trunk sewers and lacks corresponding development of laterals. This appears to be due to the fact that the proceeds of bond issues have been used for trunk sewers and that the expectation of building laterals with money from current funds has not been realized. The report suggests that surveys and estimates be made to determine the cost of continued extensions to the sewerage system with particular attention, first of all, to those districts showing the greatest need. It is even suggested that the expenditure of $90,000 in a single district which now has a high typhoid death rate and a large amount of pellagra would remove the district from a position of danger to one of safety. The report also suggests city supervision of privies, the regular collection of night-soil and the granting of authority to the Health Department to close contaminated wells, together with coöperation by the water-works department in the way of making extensions which will facilitate the closing of wells. The geological formation at Nashville is such as to increase the danger of contamination of wells from privies and cesspools. A shallow layer of soil rests upon limestone containing many crevices. The seepage from privies and cesspools passes through seams and crevices in the limestone to springs and wells. The latter, it appears, have been extensively used by a public which has assumed that because water is clear and otherwise agreeable to the physical senses it is therefore free from all danger of contamination.

PERSONALS

Mr. F. R. Williams has been appointed Assistant City Engineer of Cleveland, Ohio, in charge of new paving. He succeeds Joseph Bayne.

Mr. A. J. Cleary, Assoc. M. Am. Soc. C. E., has been appointed Second Assistant Engineer to City Engineer O'Shaughnessy, of San Francisco.

Mr. H. W. Shimer has been appointed First Assistant Engineer to City Engineer O'Shaughnessy, of San Francisco, to fill the vacancy caused by the death of Loren E. Hunt.

Mr. R. W. Gelder, Assoc. M. Am. Soc. C. E., has been appointed City Engineer of Greeley, Colo., to fill the vacancy created by the resignation of O. F. Shattuck, M. Am. Soc. C. E., now located in Indianapolis, Ind.

Mr. F. D. Holbrook, M. Am. Soc. C. E., has left the Government service to become associated with R. A. Miller under the firm name of Miller & Holbrook, Consulting Engineers, with offices in the Millikin Building, Decatur, Ill.

Mr. Joseph Bayne, Assistant City Engineer of Cleveland, Ohio, who has been in the employ of the city for more than 30 years, has resigned to take charge of the paving work of the Cleveland Railway Co. He will take up his new duties Mar. 1.

Mr. Harry K. Miller, who for the past two years has been Assistant Engineer in charge of a new survey of the streets and boundaries of the town of Montclair, N. J., and the monumenting connected with this work, has resigned from that position.

Mr. W. L. Hemmings has been appointed Smoke Commissioner of the City of Cleveland, Ohio, by Public Safety Director A. B. Sprosty. Mr. Hemmings will receive an annual salary of $1,800. Under the previous administration the position paid a salary of $2,200.

Mr. H. F. Wardwell, formerly Home Office Engineer of the Detroit Steel Products Co., Detroit, Mich., has been appointed General Sales Manager of the company, succeeding Mr. P. A. Smith, recently resigned. Previous to his present connection Mr. Wardwell was in the employ of the United States Gypsum Co.

Dr. F. W. Cunningham, of Orange, N. J., has severed his connection with the research and development work of the Newark, N. J., plant of the General Electric Co., to join the engineering-research staff of the Powdered Coal Engineering and Equipment Co., of Chicago, Ill. He will be located in Chicago after Mar. 1.

Mr. B. L. G. Rees, formerly Assistant Engineer with the New York Public Service Commission on the new subway work, will sail on Mar. 4 for Antofagasta, Chile. He will accompany Mr. Huntington Adams, M. Am. Inst. M. E., who is making the trip to investigate an engineering project in that vicinity. Mr. Rees will have charge of the survey work connected with the investigation.

Mr. T. V. Stephens, for the past two years City Engineer of Cadillac, Mich., has been appointed City Manager of Cadillac. He succeeds Mr. O. E. Carr, now City Manager of Niagara Falls, N. Y. Mr. Stephens graduated at the Pennsylvania State College in civil and sanitary engineering in 1912. Previous to his residence in Cadillac he was connected with the Division of Sewerage Investigation, Designs and Plans of the City of Cincinnati.

Mr. Samuel A. Greeley, Assoc. M. Am. Soc. C. E., until recently Assistant Engineer with the Sanitary District of Chicago, Ill., on investigations, designs and construction of sewers and sewage-treatment plants and formerly in charge of the construction and operation of the refuse incinerator of Milwaukee, Wis., has opened an office at 64 West Randolph St., Chicago, for the practice of hydraulic and sanitary engineering. Mr. Greeley graduated at Harvard University in 1903 and later took a bachelor of science degree in sanitary engineering at the Massachusetts Institute of Technology, after which for several years he was employed as assistant engineer with Rudolph Hering and George W. Fuller. He has spent considerable time in Europe investigating and reporting upon the practice of sanitary engineering there and has made a report on sanitary conditions of the City of Caracas, Venezuela.

OBITUARY

James Driscoll, a well-known contractor, died at his home in Brookline, Mass., on Feb. 20.

George R. Ray, President of the Manistee Iron Works Co., of Manistee, Mich., died on Jan. 3. Mr. Ray was prominently identified in the development of equipment, particularly the vacuum pan, for the manufacture of salt.

Col. J. M. Wilkinson, of Valdosta, Ga., died in Augusta, Ga., on Feb. 16. He was born in Liberty County, Ga., and was about 63 years old. He built the Valdosta Southern Ry. from that city to Madison, Fla., which in 1908 became part of the Georgia & Florida system. Colonel Wilkinson was made vice-president of the latter road; and when, in 1913, receivers for it were appointed, he was made one of them.

T. Ryan, a prominent contractor of Seattle, Wash., died on Feb. 10. He had been a resident of that city for 33 years. During the early part of that period he erected some of the largest buildings in Seattle. In later years he turned his attention to street paving, his best-known work being the repaving of Second Ave., Seattle. He served on the King County Commission and the City Council for several years.

George H. McPhetres, member of the Lynn Municipal Council, in charge of streets and highways, died at his home in that city on Feb. 25. Mr. McPhetres was born in Harmony, Me., and moved to Lynn in 1886, where he entered the employ of the street department, with which he was connected in all for 27 years. He was commissioner of streets and highways when Lynn changed its charter in 1912, under which he was elected a member of the Municipal Council. At the time of his death he was serving his second term in that capacity.

Bryce R. Blair, who as chief engineer constructed the Jefferson branch of the Erie R.R. and was also engaged in the construction of the Bloomsburg division of the Delaware, Lackawanna & Western R.R., the Broad Top Mountain R.R. at Taxton, Penn., and a large section of the Albany & Susquehanna division of the Delaware & Hudson R.R., died at Carbondale, Penn., on Feb. 11. Mr. Blair was 83 years of age and a native of Glasgow, Scotland. He served for seven years as City Engineer of Carbondale and was largely influential in the development of the city's municipal improvements.

Peter James Cunneen, Manager of the Lassig plant of the American Bridge Co., at Chicago, died on Feb. 13. He was born in Adrigoe, Ireland, in 1859. In 1878 he entered the employ of the old American Bridge Co. and remained with the company and its successors until the formation of the present company. Mr. Cunneen was Secretary of the Chicago Forge and Bolt Co. and later of the American Bridge Works. After the formation of the present American Bridge Co. he served as purchasing agent in charge of the Chicago district and was later made Manager of the Lassig plant, which position he held for about 15 years, up to the time of his death.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 28 to Mar. 3. Annual convention in Pittsburgh. Secy., E. L. Powers, 150 Nasau St., New York City.

CENTRAL RAILROAD CLUB.
Mar. 9. Annual meeting in Buffalo. Secy., H. D. Vought, 95 Liberty St., Buffalo.

VERMONT SOCIETY OF ENGINEERS.
Mar. 9. Annual meeting in Burlington. Secy., George A. Reed, Montpelier.

NEW ENGLAND RAILROAD CLUB.
Mar. 14. Annual meeting in Boston. Secy., W. E. Cade, 683 Atlantic Ave., Boston.

WISCONSIN ELECTRICAL ASSOCIATION.
Mar. 16-17. Annual convention in Milwaukee. Secy., George Allison, Milwaukee.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 21-23. Annual meeting in Chicago. Secy., E. H. Fritch, 900 So. Michigan Ave., Chicago.

NATIONAL RAILWAY APPLIANCES ASSOCIATION.
Mar. 21-23. Annual meeting in Chicago. Secy., B. V. Crandall, 1824 Lytton Building, Chicago.

ILLINOIS GAS ASSOCIATION.
Mar. 22-23. Annual meeting in Chicago. Secy., H. H. Clark, 136 So. Harvey Ave., Oak Park, Ill.

Maine Society of Civil Engineers held its annual meeting at Augusta in February and elected the following officers for 1916: President, Paul D. Cargent; vice-president, Harry E. Green; secretary, Frank E. Pressey; directors, I. W. Barbour, John Calvin Stevens, E. C. Jordan, T. W. Clark, S. A. Moulton.

Canadian Mining Institute is holding its annual meeting (Mar. 1 to 3) in Ottawa. The president-elect is Arthur A. Cole, mining engineer for the Temiskaming & Northern Ontario Railway Commission, of Cobalt. The secretary is H. Mortimer-Lamb, Room 911, Ritz-Carlton Hotel, Sherbrooke St., West, Montreal.

Western Society of Engineers—A joint meeting of the Chicago sections of the American Institute of Electrical Engineers and the Illuminating Engineers Society and of the

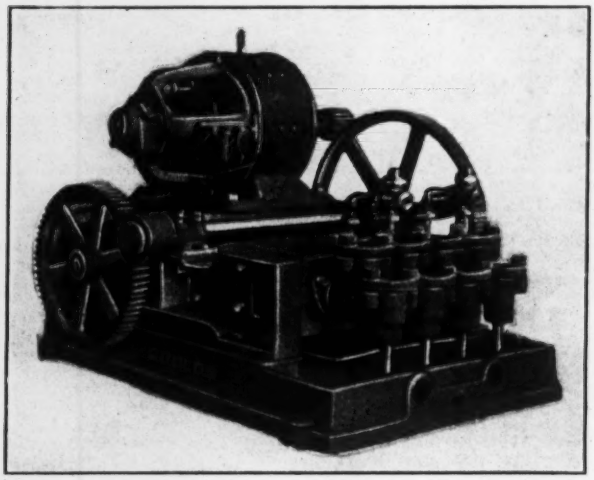
electrical section of the Western Society of Engineers was held in the rooms of the latter in Chicago on Feb. 28. The general subject of the evening was street illumination, three papers being presented, by J. R. Cravath, A. C. King and F. A. Vaughn.

Joint Meeting of Electricals and Electrochemicals. New York sections, will be held in the auditorium of the Engineering Societies Building on Friday, Mar. 10, at 8:15 p.m. The subject of the meeting will be "Electrolysis," and two papers will be presented. On behalf of the American Institute of Electrical Engineers a paper will be presented by Burton McCollum, of the Bureau of Standards, and G. H. Ahlborn, entitled "The Influence of Frequency of Alternating or Infrequently Reversed Current on Electrolytic Corrosion." On behalf of the American Electrochemical Society a paper will be presented by Prof. William H. Walker, of the Massachussetts Institute of Technology, entitled "Electrolytic Corrosion of Metals."

Appliances and Materials

High-Pressure Oil Pump

A motor-driven pump, shown in the accompanying illustration has been designed by the Goulds Manufacturing Co., Seneca Falls, N. Y., for forcing oil under the bearings of machinery. The pump is a single-acting horizontal quadruplex with ⅞x4-in. cylinders; it has a capacity of 2 gal. per



QUADRUPLEX OIL-PRESSURE PUMP

min. against 1,200 lb. per sq.in. In the base is a 10-gal. reservoir. The cylinders are brass lined; plungers are of hardened tool steel and crossheads of bronze. Connecting-rods are of cast steel, babbitted on the crank end and bronze bushed at the crosshead.

* * *

Combination of Pump Designs

The American Steam Pump Co., Battle Creek, Mich., maker of the "Marsh" and "American" types of boiler-feed and other pumps, has now put out the "American-Marsh" design, which combines the general features of the "Marsh" line with the "American" valve. The main valve is a balanced-piston type with expansion rings; the auxiliary valve is of a semirotary disk type, mechanically actuated by a lever arm connected to the piston crosshead. The new line covers heating-system, boiler-feed and vacuum pumps.

* * *

Improved Cores for Cast-Iron Pipe

The commercial development of the type of cores, for use in casting iron pipe, invented by the late H. M. Fletcher, of Cincinnati, has been taken up by the concern, Fletcher Cores, 820 Gwinne Building, Cincinnati. The first steps in this invention were taken with the coöperation of the late Matthew Addy, who operated pipe foundries at Newport, Ky., and Addyston, Ohio. It was designed to obviate the necessity of a thick combustible layer and the inequalities of wall found with hay-rope cores.

A vented cast-iron core bar, larger than the ordinary, is used. It is spirally wound with strips of embossed paper and in some cases with a follower of hemp twine. A coating of loam is then put on. There is claimed to be a saving of 40 to 60% in the amount of loam used and a small saving in cost of paper strips over hay rope. The time required to form and dry the core and to clean the cast pipe is reduced.

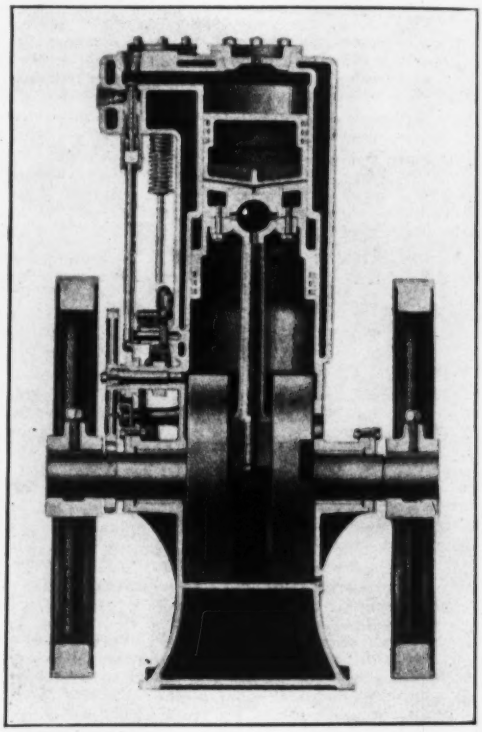
Fletcher cores were first put into practical operation in the plant of the Warren Foundry and Machine Co., Phillipsburg, N. J. and have recently been adopted by the National Cast Iron Pipe Co., Birmingham, Ala. The largest pipe yet cast with these cores is 16 in. in diameter.

* * *

Vertical Gasoline-Driven Air Compressor

A new simple design of portable self-contained gasoline-driven air compressor has been completed by the Lyon-Atlas Co., Indianapolis, Ind. It is built for pressures of up to 200 lb. per sq.in., and in three sizes—for 50-, 100- and 150 cu.ft. piston displacement. The arrangement, shown in the accompanying section, is very simple and compact.

The engine is of single-cylinder four-cycle type. By use of a differential piston and cylinder only one piston rod is required. The air is admitted through a port in the case and a registering port in one crank disk; it is first compressed to about 20 lb. in the crank case and flows into a receiving passage and into the annular space of the second cylinder. To unload the compressor, the air-admission valve between the crank case and second cylinder is held open at a predetermined pressure. Most of the working parts are in easy reach and plain view on the outside. By disconnecting the



VERTICAL DOUBLE-STAGE GASOLINE-DRIVEN AIR COMPRESSOR

outside pipe and removing the casing bolts the top of the casing may be swung back on hinges, exposing crank, crank disks, piston and casing interior.

The engine is hit-or-miss governed. While the standard engine is intended for gasoline, it can be adapted to kerosene or any gas. To secure cold water around the compressor cylinder and warm water in the engine jackets, the cooling-water flow is from compressor to engine. The three sizes develop 9, 18 and 25 hp.; the shipping weights are 1,500, 2,900 and 4,000 lb.

* * *

Insulating and Rust-Preventing Paint

Under the trade name "Rostnicht" the Billings-Chapin Co., Cleveland, Ohio, is making an insulating and anti-corrosion paint for steel. This paint consists of zinc chromate and inert pigments (among which portland cement is commonly supposed to figure largely) carried in a varnish vehicle. It is claimed to be impervious to water, brine, oil, fumes and gases. It is furnished in seven colors.

Enc lopedia en Español de Maquinaria para Construcciónes, Página 86

Engineering News

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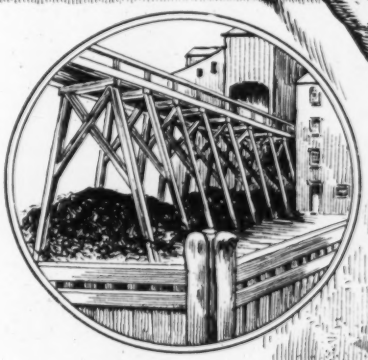
Contents, First Page
Advertising Index, Last Page

KYANIZED SPRUCE

WIDENS THE FIELD OF WOOD CONSTRUCTION



WOOD is thought of as fast decaying—inflammable. If rendered decay-proof, it is thought of as sticky, discolored, smelly, heavy, disagreeable to touch and look at, impossible to paint, and about as fireproof as powder.

Berlin Mills KYANIZED SPRUCE is a decay-proof timber which is NONE of these things. Kyanization has no effect on color, smell, the timber takes paint perfectly, does not bleed in the hottest weather, and is far less inflammable than untreated timber. It is light weight and easily workable, yet of great strength.

Use BERLIN MILLS Kyanized Spruce where ordinarily you would use other more costly material. Use it for sills, poles, posts, basement floors, trestling, bridges, ties, surveyors' stakes, roofs, gutters. It is really decay-proof. Hundreds of thousands of feet are being used throughout the country for these and allied purposes. Write for details.

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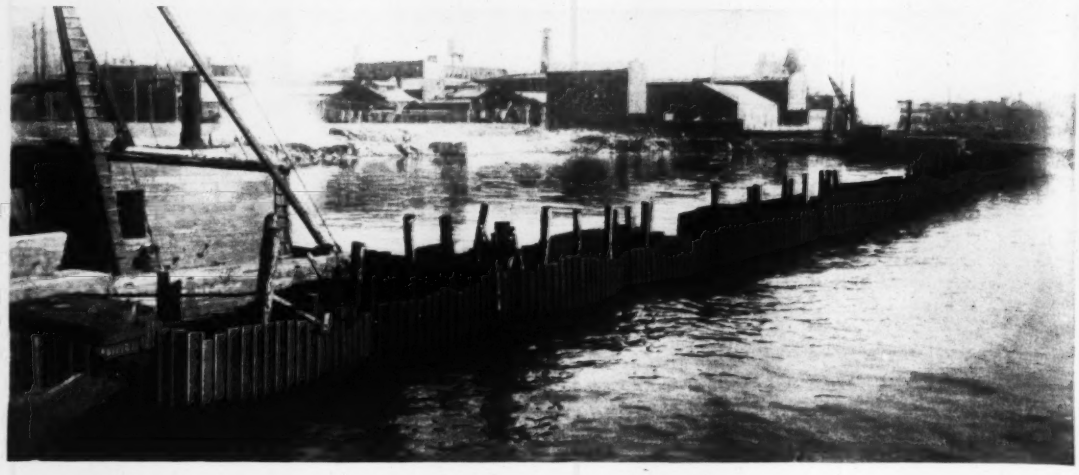
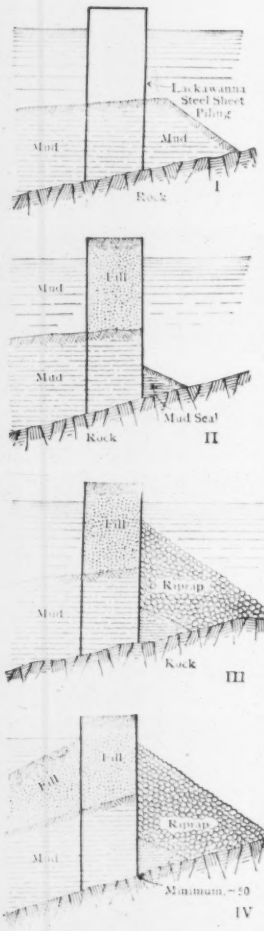


Steps in the construction of the Lackawanna Steel Sheet Piling Cofferdam for 46th Street Piers, New York City



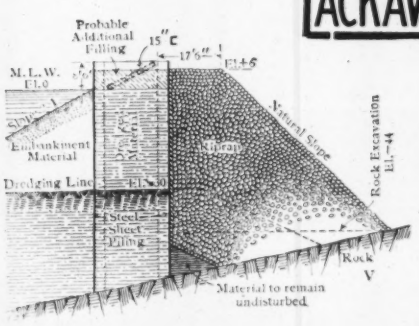
The above view shows the river or deep water side of the cofferdam when all the Lackawanna Steel Sheet Piling had been driven and before the anchor piles in the cofferdam had been removed.

The progressive steps in building the dam after the installation of the steel sheet piling pockets are shown in the sketches. The steel sheet piles were driven through an overlying 20 feet or more of mud and silt as a bottom support and seal on top of bed rock as shown in Step I.

Step II was to tub out the mud lying on the shore side of the cofferdams and into the cell of the dam, leaving a seal at the inner toe of the dam. Step III was to dump part of the riprap against the shore side of the dam, and Step IV to place the fill of mud up against the river side. Step V includes completion of placing of riprap on the shore side and pumping out the dam, and shows a typical section of the finished dam. Examination of these diagrams will show that at various times during the process, the dam would be in rather precarious state of equilibrium if the processes indicated on the steps were continued entirely across the dam. For instance, in Step III, if the riprap were placed *entirely* before the fill was placed on the river side there would be a pronounced tendency to turn over toward the river.

In order to avoid such possibility the filling and excavating on either side of the cofferdam were carried out with extreme caution in alternate sections along the dam, so that no great length of the dam was subjected to excessive pressures from either side at any one time.

Additional construction details will be given in next week's advertisement.



LACKAWANNA STEEL COMPANY

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For Great Britain and British Colonies in the Eastern Hemisphere, Cargo-Fleet-Iron Co., Ltd., Middlesborough, England. For France, Italy, Spain, French Colonies and Protectorates, Italian Colonies and Spanish Colonies in the Eastern Hemisphere; Cie Des Forges & Aciéries de la Marine et d'Homécourt, Paris, France.

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Engineering News

VOLUME 75 MARCH 9, 1916 NUMBER 10

Electric Dredge Used on River Improvement in Washington

By J. H. Walter*

A 20-in. electric suction dredge, the "Puyallup No. 1," is now in service in Washington, engaged in removing 3,000,000 cu.yd. of subaqueous material. This work is a part of the Inter-County River Improvement, a joint project undertaken by King and Pierce Counties, Washington, for the purpose of relieving the flood damage of the White-Stuck and Puyallup Rivers. Widening, deepening and straightening the channel require the removal of 4,620,000 cu.yd. A contract has been let for straightening 8 mi. of the channel and the removal of 3,000,000 cu.yd., based upon the counties' furnishing a 20-in. suction dredge.

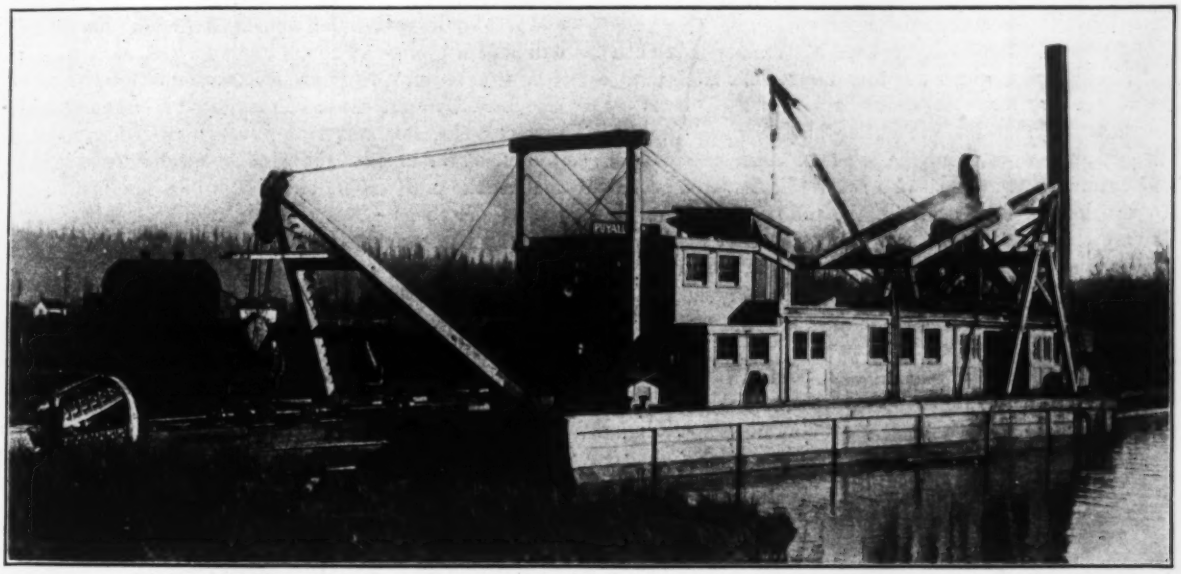


FIG. 1. ELECTRIC DREDGE "PUYALLUP NO. 1," BUILT FOR KING AND PIERCE COUNTIES, WASHINGTON

The dredge was designed by the writer for the counties and built under contract, at a cost of $70,000. It is now being operated at a low unit price for yardage, but carries with it an agreement to purchase the dredge at 75% of its original cost, if the counties so elect, at the end of the contract.

This dredge is electrically driven, but has a steam auxiliary on the line shaft of the winding machinery. It has a timber hull 9 ft. 6 in. by 40 ft. by 115 ft., in which there are 172,000 ft. b.m. of lumber and over 27,000 lb. of iron and steel. The dredge draws 3 ft. 9 in., showing a displacement of about 500 tons.

The bottom is made of 10x12-in. timbers, all 40 ft. long. The longitudinal bulkheads, seven in number, are of 10x18-in. timbers, five strakes each; deck beams and stanchions are of 10x10-in.; the crossbraces are of 4x12-in.; and the deck is of 4x6-in., while the cross-bulkheads are of 8x18-in. timbers. The hold is divided into 10 fairly equal water-tight compartments. A 9-ft. 9¾-in. by 24-ft. well in the forward end takes the ladder trunnions, thus minimizing the overhang of the A-frame supporting the ladder hanger. The main deck house provides no quarters for crew, but simply houses the machinery, with a roomy pilot house set in the upper half in the forward end. In the pilot house are controls for the complete operation of the dredge, with the exception of the priming of the main pump and the operation of the bilge pump.

The ladder is built up of four 24-in. 100-lb. I-beams, two on each side, with heavy cast-steel strong-backs and lattice bracing. It is 50 ft. long from the center of the trunnions to the back ring of the cutter head and can be operated in any position from horizontal to vertical. The cast-iron suction pipe, 20 in. in inside diameter, passes through the starboard trunnion, while the cutter drive is transmitted through a countershaft in the port trunnion. Both of these passages through the trunnions have good and sufficient clearance with the sides of the

*Assistant Engineer, Inter-County River Improvement, Tacoma, Wash.

FIG. 2. TWENTY-INCH PUMPING UNIT OF ELECTRIC SUCTION DREDGE

trunnions. The original cutter was designed for very soft digging, was 8 ft. in diameter, of the helmet type, and was driven by a 100-hp. 600-r.p.m. reversible and variable-speed motor. By making the bull-wheel 86 in. in diameter only three reductions were found necessary to obtain the proper speed for the cutter.

At present there is being used a straight-blade cutter, 6 ft. in diameter, which was found advisable on encountering some very hard clay. No babbitt is used in the two forward bearings on the cutter shaft, where this gets the extreme wear from the sand and silt stirred up by the cutter. But in its stead a removable cast-iron bearing, in two halves, is inserted in the pillow block, affording a very cheap and quick renewal. The shortest bend of the suction pipe has a 5-ft. 1-in. radius, and there are only three bends on the dredge in both suction and discharge pipes.

The main pump is of the "convolute" type, as designed and built by the Bucyrus Co., of South Milwaukee. It has a steel shell and runner, with renewable front and back liners of soft-steel plate and a medium-steel nose ring—also renewable. The pump is direct connected through a friction relief coupling, of the same company's latest design, to an 800-hp. 360-r.p.m. variable-speed motor. The unit as a whole is assembled on a bed 7 ft. 6 in. by 26 ft., built up of six parallel 12-in. I-beams and ½-in. steel plates top and bottom. There are enough intercostals in this bed to make it a most rigid foundation, and it takes its seat directly on the five center longitudinal bulkheads.

A 4-in. steam ejector primes the pump in 35 to 45 sec. The back flow from the discharge pipe is taken care of by a cast-steel flap valve.

Four of the units of the winding machinery have interchangeable pin-friction clutches, while the fifth unit—the ladder hoist—has a band friction. All five are assembled on one line shaft at the forward end of the main deck house, the line shaft extending to outside gypsies. This line shaft is driven through one center shaft by a 75-hp. 600-r.p.m. reversible and variable-speed motor. In addition there is an auxiliary 10x12-in. double steam engine, connected to the line shaft with a jaw clutch. The controls for the winding machinery are arranged in the pilot house with hand levers for the friction and with foot levers on the brake bands. This arrangement gives the leverman quicker action than the

FIG. 3. WINDING MACHINERY OF ELECTRIC SUCTION DREDGE "PUYALLUP NO. 1"

hand levers on the brakes. The machinery was manufactured by the Washington Iron Works, of Seattle. A view of the winding machinery is given in Fig. 3.

Each one of the 10 water-tight compartments has a 6-in. suction and a gate valve governing it, from a 12x7x12-in. duplex steam pump. It will deliver 400 gal. per min. and, having also an outboard suction, is connected up to four 2½-in. hydrants for fire protection. This pump also supplies the circulation for the water jackets of the thrust bearings and stuffing-box on the main pump. To supply steam for this duplex pump and also the auxiliary engine on the winding machinery, there is on the stern of the dredge a horizontal boiler having 582 sq.ft. of effective heating surface. The necessary steam lines are also provided for portable siphons all over the hull and for heat in the pilot house.

Drum-type controllers were used for the two smaller motors, while the main pump motor is controlled through a master control and contactor panels. The resistance grids are housed in a well-ventilated addition on the back of the pilot house. All the electrical equipment was made by the General Electric Co.

In addition to the dredge proper there were furnished twelve 12x24-ft. pontoons, 500 ft. of standard pontoon pipe, 3,000 ft. of standard levee pipe, gates, elbows, sleeves, etc. There was supplied also a 4-ft. 6-in. by 26-ft. by 48-ft. derrick scow. On this scow is a 10¼x12-in. three-drum hoisting engine and a stiff-leg derrick with a 40-ft. boom. This derrick scow was designed for general use, but most particularly for clearing the river of snags and drift.

The Dredge Tested Before Service

Before delivering the dredge to the contractor for operation, a thorough test run was made. The discharge was extended 3,000 ft. and elevated at the end to 25 ft. above the surface of the water at the dredge. The velocities were obtained by putting 6-in. wooden balls, partly loaded, into the suction pipe at the cutter head and also by emptying gallon jugs of potassium permanganate. In all, 18 of these trials were made, with fairly good results. The vacuum, pressure and power consumptions were taken as averages over a period of 19 hr. of steady pumping. During this time only clear water was pumped, to obtain more uniform readings than can be obtained while digging material.

The following results were obtained:

Average pressure	= 43 lb. =	98.9 ft. head
Average vacuum	= 19 lb. =	21.5 ft. head
Total pressure		= 120.4 ft. head

Velocity as measured = 15.3 ft. per sec. Therefore the output was $\frac{15.3 \times 2.18 \times 62.5 \times 120.4}{550} = 456.3$ hp.

The power consumed was 505.8 kw.-hr. = 678 hp. input. The efficiency of the unit was $\frac{456.3}{678} = 67.3\%$.

The efficiency of the pump proved to be $\frac{67.3}{90} = 75\%$, the motor efficiency being 90%.

Tweeden & Marsh, of Tacoma, were the general contractors for the construction of the dredge. Puyallup Dredging Co., of Seattle, is the contractor for the dredging. W. J. Roberts is chief engineer of the project.

Interior Wall Finish in Panama Canal Hospital Buildings

The sulphate of zinc treatment for concrete walls to be afterward painted has been adopted for the interior wall finish of the permanent hospital building at the Panama Canal. The report of Geo. M. Wells, Resident Engineer of the Building Division, describes these buildings and their interior wall finish as follows:

A great deal of study was given to the design of these buildings in an effort to decide upon that form of composite construction that would make for economy and yet meet all the rigid requirements demanded by the health department as regards character of interior and exterior finish. It was finally decided to make the veranda and main-building walls of poured reinforced concrete, while the floors with a clear span from wall to wall across the building were to be constructed of reinforced concrete overlaid with terrazzo mosaic tile or some composition flooring for finish. Intermediate walls 6 in. or over in thickness are also to be built in reinforced concrete. Walls less than 6 in. thick are to be laid up of hollow cement blocks plastered with two-coat cement and sand stucco troweled to a smooth dead surface. The concrete walls are to be rubbed and filled to a similar finish.

The health department demanded that walls should be both smooth and of sufficient hardness to withstand chipping at corners, cracking or denting, and further that the treatment of the wall finish should be such that the wall could be washed with antiseptic solutions if necessary, without in any way injuring the finish.

It is proposed to meet these requirements with the cement walls as described, treated with chemical and painted with special paints as follows: The walls will be first given two coats of a wash of sulphate of zinc, mixed with equal parts by weight of zinc and water. The effect of this wash is to neutralize or destroy the alkalinity of the hydrated lime which comes to the surface of the concrete wall as calcium hydroxide and changes the latter into a mixture of calcium sulphate and zinc oxide. This gives a surface that has no leaching effect on linseed oil. Two coats of flat-finish oil-mixed paint of any color desired will then be applied. On this will be placed as a final finish a third coat of enamel washable wall paint.

It can be shown that a concrete wall treated in this manner will cost far less per square than the usual three-coat hard-finish white plaster sized and tinted to the color desired. The difference in cost between the two methods is estimated to be approximately $12 per 100 sq.ft. in favor of the painted wall with the additional advantage gained of a harder and more durable surface.

The just described sulphate of zinc treatment for concrete walls that are to be painted was discussed by Charles MacNichol in a paper read at the annual meeting of the American Society for Testing Materials in 1910. Mr. MacNichol recommended that the solution of zinc sulphate and water be applied with an ordinary bristle brush after the cement is dry, and that after application 48 to 72 hr. be allowed for the wall to dry before applying paint. Mr. MacNichol's paper also contained a statement by Dr. Allerton F. Cushman describing the chemical action of the sulphate of zinc in the same manner as reported by Mr. Wells and expressing approval of the treatment.

Cost of Highway Surveys—According to data recently compiled by the State Engineer of Oklahoma, W. P. Danford, the cost of making surveys for state roads has varied from $2.95 to $33.33 per mi., the average for 1,370 mi. being $10.05. The work was done by county engineers, who receive $5 per day and expenses. The expenses include the pay of two assistants at $2 per day and transportation. The average of 46 counties was $10 per mi., and leaving out the few high ones, the average cost of the remaining 38 counties was $6.70 per mi. This includes both alignment and level lines and the drafting of a plan and profile. The alignment of Oklahoma roads is not difficult to survey, for they invariably follow section lines, north and south and east and west. The county commissioners are reluctant to change the alignment for any other reason than sheer impassability, and this constitutes one of the state's highway improvement problems.

Concrete Strength Not Result of Aggregate Strength

By Thomas Hendrick*

To one who has had recourse to the literature upon aggregates in concrete it is evident that first-hand information in regard to the relative efficiency of different kinds of stone, when employed as coarse aggregate, is lacking, and the information that can be found is not conclusive. The data in handbooks are based upon the fact that stones ranging from very hard to very soft will, when introduced into concrete as aggregate, give a resultant that varies in strength directly as the strength of the stones themselves. Such a conclusion seems to be taken for granted. Standard texts, moreover, assume from the fact that experiments on the same aggregate give the result that the "densest stones make the strongest concrete" that such a fact is true for all stones, although differing in kind. From other data on tests of concrete made from traprock alone is based the conclusion that the strength of concrete is proportionate to the shearing value of the stone.

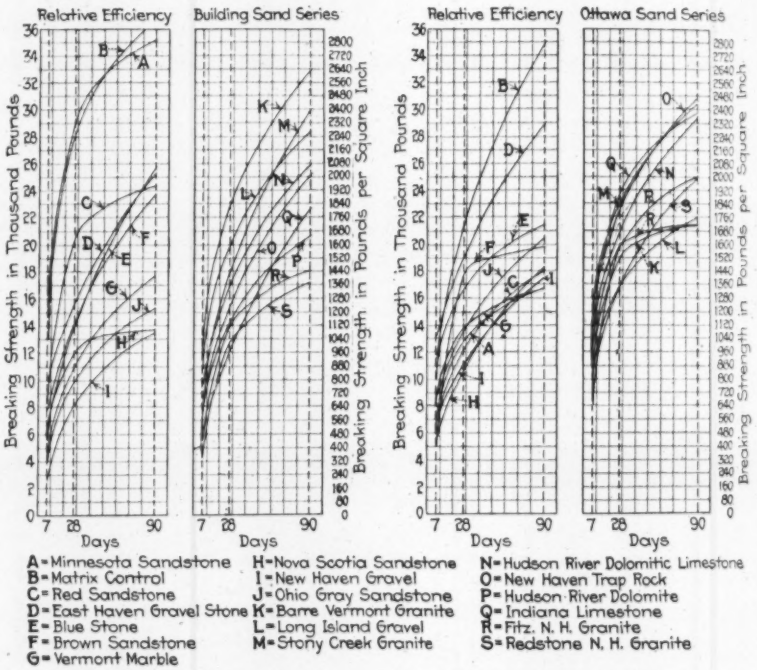
In this article are given the results of experiments performed at the Cement Testing Laboratory of the Sheffield Scientific School, of Yale University, showing the relative efficiency of 16 kinds of broken stone and two kinds of gravel when used as aggregate; and from these results the importance which should be placed upon the factor of adhesion in the consideration of a stone as an aggregate is developed.

An elaborate description of the stone and gravel experimented upon is out of place here, but a brief mention of the commercial names and essential characteristics is of value. The materials used were as follows: Five sandstones—Connecticut brown, Nova Scotia drab, Massachusetts red, Minnesota Kettle River pink and Ohio gray; Vermont marble; Indiana limestone; two gravels—New Haven and Long Island; Hudson River dolomite; Hudson River dolomitic limestone; four granites—Fitzwilliams (N. H.), Barre (Vt.), Redstone (N. H.) and Stony Creek (Conn.); and New Haven traprock.

Of the sandstones the most easily crushed was the Minnesota. Its grains were clean and granular, as compared with the earthy texture of the other sandstones. Of the granites Redstone and Stony Creek were similar in reddish color and in resisting crushing, and Barre resembled Fitzwilliams in its physical characteristics. Indiana limestone in texture was something like Ohio gray sandstone, its cementitious material being of a somewhat earthy substance. The grains of East Haven gravel stone were sharp and glass-like. The traprock, dolomite, dolomitic limestone and bluestone were of such structure that it was necessary to employ the usual acid test to tell them apart. Vermont marble reduced itself, when struck with a hammer, to a substance that looked like salt. The sea-washed hard Long Island gravel contrasted with the clayey impure New Haven gravel.

Actual figures for crushing strength of seven of these stones, taken from Edwin C. Eckel's book on "Building Stones and Clays; Their Origin, Characters and Examination," are as follows: Strength in pounds per square inch, Barre (Vt.) granite, 17,182; New Haven trap, 9,500; Connecticut brown standstone, 11,696; Massachusetts sandstone, 11,517; Indiana limestone, 5,635; and Vermont marble, 8,670. These figures show the relative strength of the raw stone, a general knowledge of which is all that is essential to the present purpose.

It may be mentioned, however, that tests of stone in the raw show considerable difference from tests of the stone as it is used in the aggregate. Here it is used not in a solid mass, but in small particles, the natural cementitious material having been replaced by the matrix used; and tests of raw stone cannot be taken as an index of the way in which a particular stone will act as an aggregate.



COMPARATIVE COMPRESSIVE STRENGTHS OF CONCRETE WITH CERTAIN AGGREGATES AND OTTAWA AND BUILDING SANDS

By making compression tests on cylinders (size 4x8 in.) of concrete, proportioned 1:2:4 by volume reduced to weight, the aggregate alone being varied, a comparative value of the different stones as aggregate was determined. The stones were made of the same size by passing through a 1-in. and retaining on a ½-in. sieve. To secure uniformity, the same kind of sand and cement was used throughout, two series being used—building-sand and Ottawa sand series. Standard methods of mixing and proportioning were employed. The comparison is based upon tests of 7, 28 and 90 days, for which curves are shown herewith.

The results obtained are given both in actual breaking strength and in pounds per square inch. Generally speaking, the tests of 28 and 90 days emphasize the results of 7 days. Tests for the Ottawa sand series run high

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with tests for the same stones in the building sand series run low. Special attention should be given to the curves of Minnesota sandstone in the building-sand series and to Indiana limestone in the Ottawa sand series, also to that of the matrix control in both series. The Minnesota sandstone and the Indiana limestone were the two softest stones used; yet the testing values are higher in the case of the Minnesota and about as high in the case of the Indiana for their respective series. The matrix control maintains throughout comparatively high results.

What the Experiments Show

From the outcome of the tests it cannot be asserted that shearing strength is the criterion of the fitness of an aggregate to give strong concrete. The other forces resisting compression—the shearing strength of the matrix and the interlocking factor, adhesion—must be considered with it, the three forming a unit of resistance. The difference of breaking values for similar stones in the two series is explained not by the effect of changing the shearing strength of the aggregate, but by the change in the factor of adhesion when a new aggregate is introduced. In the building-sand series the matrix, in the case of the Minnesota sandstone, has a greater adhesive force (by reason of the superior testing values) than it has in the case of the other stones, because with this stone as aggregate the matrix makes an entirely homogeneous mass, or a more nearly monolithic structure; and similarly in the case of the Indiana limestone in the Ottawa sand series the comparatively high testing value is due to adhesion of the matrix and aggregate. In selecting these two examples, moreover, the exceptions are not taken, because of the four granites used, Stony Creek and Redstone, nearly equally strong in resisting shear when raw, failed to show the same comparative results when used as aggregate; and in the same way Barre granite exceeded the Fitzwilliams granite when used in the concrete, although practically equal in shearing strength in the raw stone.

It is maintained by some that it does not make any difference what stone is used as aggregate, so long as its shearing strength is far in excess of that which the matrix will stand; that the matrix will fail anyway; and that if the adhesion is strong enough, the ultimate strength of the concrete will approach, but in no case can it exceed, the value of the shearing strength of the stone. Yet the specimens of pure matrix failed at a value far in excess of the value for which specimens of granite aggregate fail—a fact which nullifies the theory that the strength of the matrix determines the ultimate strength of the concrete and which not only emphasizes the importance of adhesion, but seeks for its very explanation in the power (high or low) of the matrix to interlock with the aggregate, whether the latter is granite, trap, sandstone or limestone.

Compression Depends on Adhesion

It is hard to see any explanation for these results other than the high variations of the adhesion of matrix and aggregate. One stone, with building-sand matrix, gives concrete of greater strength because of adhesion; another stone, with Ottawa sand matrix, gives greater strength for that series for the same reason. Adhesion, in turn, depends upon the substance contained in the stone. Minnesota sandstone is composed of clean and granular grains, giving as nearly as possible perfect adhesion with building-sand matrix; but as far as its strength alone is concerned, it pulverizes when pressed between the thumb and forefinger. As in the case of a bridge-pier support that is made to rest upon a bed of sand, providing there can be no leakage of sand, so, too, the loose grains of Minnesota sandstone can be made to withstand a greater load than a hard granite, providing the adhesion is such that there is no leakage of the minutest grain. The moment the bond breaks there is a snap like a broken stick, the specimen failing completely; but when the bond of adhesion does not break until high testing values are reached, as the experiments show, there is no leakage until those points are reached, and the concrete is capable of withstanding a great pressure.

Hence it is believed that the saying, "The stronger the aggregate, the stronger the concrete," is true in only a limited sense; and that these experiments establish the fact that in many cases, stones, which were considered unfit for concrete, can be used to produce a better grade of concrete than a more expensive imported stone will make.

Powder-Hoist Outfit Inspected for Safety Features

The city engineer of a large city in the far West sends a report submitted by one of his assistants who was delegated to inspect the outfit used by a well-known powder company in handling explosives at its property on the waterfront. The following is a condensation of the report, names and location being omitted:

As per your request, I have examined the hoisting apparatus used by the ——— Powder Co. in hoisting powder from barges to the wharf at its docks and fully concur with Captain ———, of the Harbor Patrol, that it is unsafe and may at any time cause the explosion of an entire barge of powder.

During the four years I was United States Deputy Mineral Surveyor for Colorado I had the pleasure of examining many hoisting plants, but cannot recall having seen any quite as crude as the one in question.

The engine is a 2½-hp. gasoline engine, which exhausts directly to the engine room and within 4 ft. of the gasoline-supply tank, which is a large tin can entirely inclosed by the surrounding atmosphere. Should the engine fail to operate at a time when a load of powder is raised 22 ft., there is no adequate means to prevent its falling back upon the powder-laden barge, in which event, should it explode, the laborers would all be subject to being docked for the time spent in midair and actually off the job.

At the outer end of the derrick stands a 12x12-in. post, held a little more than vertical by means of timbers, ropes, pins, spikes and laborers. This post is so ingeniously arranged as to turn on a bottom pivot by the aid of man, thus allowing the load, when raised above the dock floor, to be swung in and lowered unsafely to place. The boom—or perhaps I should say boomerang, for it always returns to the low side without assistance—is a beautiful specimen of second-growth fir and speaks volumes for the age to which such timber can be used. It projects about 12 ft. at an angle of from 80 to 100° and is equipped at its outer end with three pulleys, two defunct and one less so. This boomerang is held by a cable fastened to the top of the center post, which cable is still in a good state of preservation. The ½-in. hoisting line, however, shows signs of antiquity and is supplied with a cheap hook to which it holds mainly by force of habit. From this hook is swung the platform cage, also evidently of domestic design, swung by two ropes fastened to the wooden cage by fence staples and crooked nails. On these platforms, I am told—for I had no desire to see—the men raise eight 50-lb. cans of powder to each load.

This infernal machine is located about 300 ft. from one of the stone piers of the railroad bridge which spans the river at that point, and only a few miles from our own City Hall. I heartily recommend that it be closed to future operations, or that some inspector, whose salary is more commensurate with the risk than your humble servant's, be placed in charge.

Columbia Highway Tunnel

By Henry L. Bowlby*

The construction of the Columbia River Highway along the south banks of the Columbia River in Oregon is offering many opportunities for novel engineering structures. Many concrete bridges and viaducts of unusual design have already been built; a number of them were described in *Engineering News* of Dec. 10, 1914, and Jan. 14, 1915.

In Hood River County, 5 mi. west of Hood River City, a barrier was encountered in the form of a solid rock cliff rising abruptly from the river to a height of nearly 500 ft. Here a bench, or saddle, a few hundred feet wide occurs, and the ledge continues to a height of 2,000 ft. or more. This rocky ledge is known locally as Storm Cliff and also as Mitchell's Point.

An old county road existed for many years over Mitchell's Point. It was narrow and very steep, having in one place a 23% grade 400 ft. long. In 1913-14 when the location surveys of the Columbia Highway were made under the direction of the writer, a highway tunnel was planned through Storm Cliff. Its length was to be 400 ft. The solid basaltic rock cliff seemed to offer an excellent opportunity to reproduce in America the Swiss Axenstrasse, but on a grander scale. Comparative estimates showed that a highway around the face of the cliff, with a 400-ft. tunnel and a 200-ft. concrete-viaduct approach, would cost less to build than a road over the bench, or saddle. The latter route was a mile longer on account of the additional rise and the 5% maximum grade.

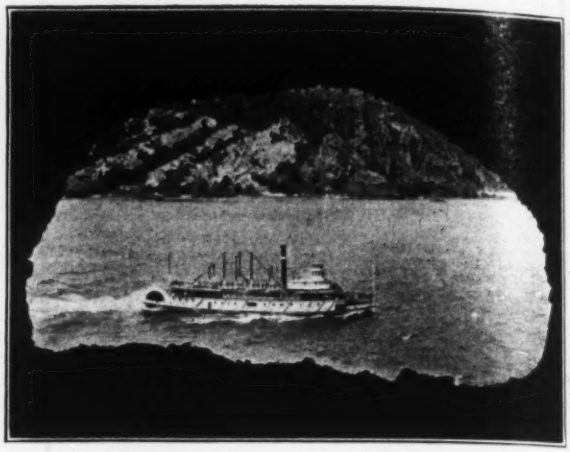

FIG. 2. VIEW FROM WINDOW OF TUNNEL, LOOKING OUT ON COLUMBIA RIVER

In July, 1914, the State Highway Commission promised the citizens of Hood River County that the state would expend $50,000 on the Mitchell's Point section of the Columbia Highway if the county would vote a bond

*Recently State Highway Engineer of Oregon, Portland, Ore.

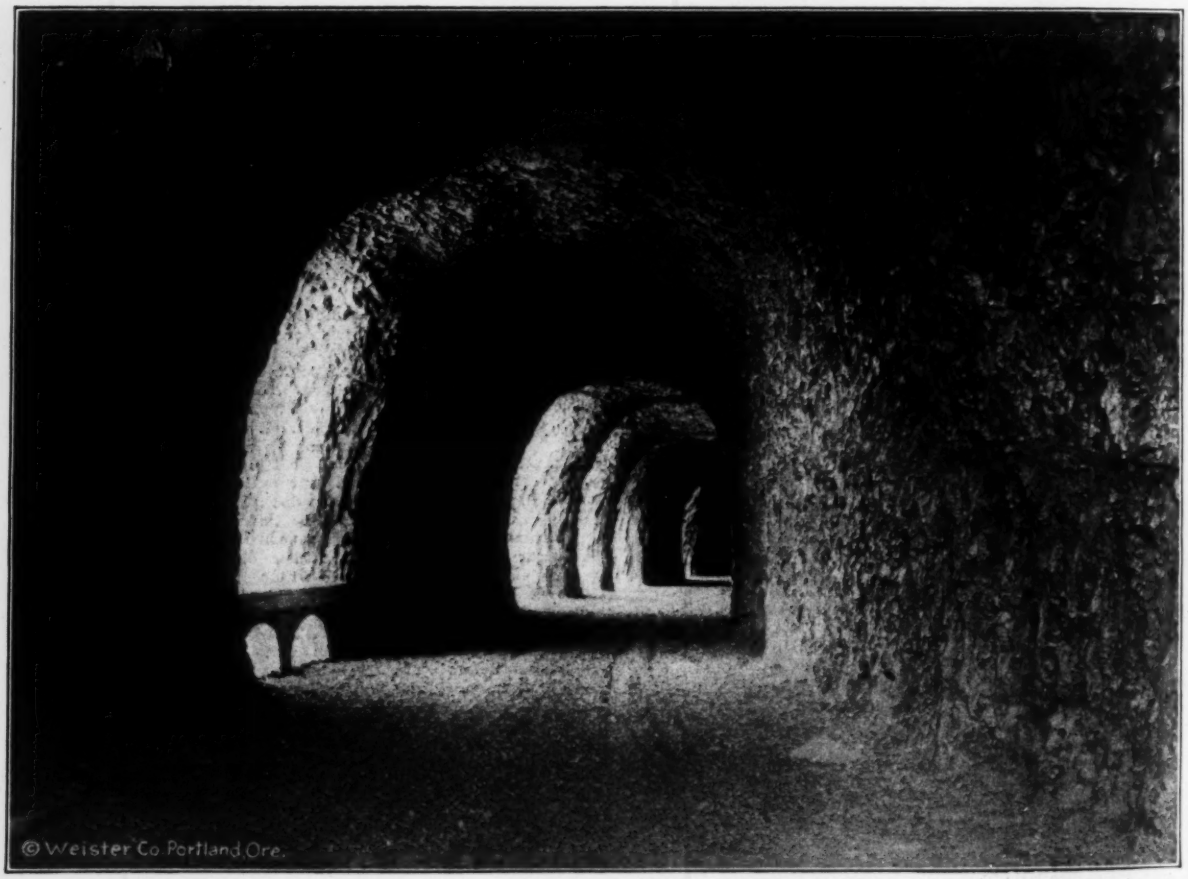

FIG. 1. INTERIOR VIEW OF MITCHELL'S POINT TUNNEL ON THE COLUMBIA HIGHWAY IN OREGON

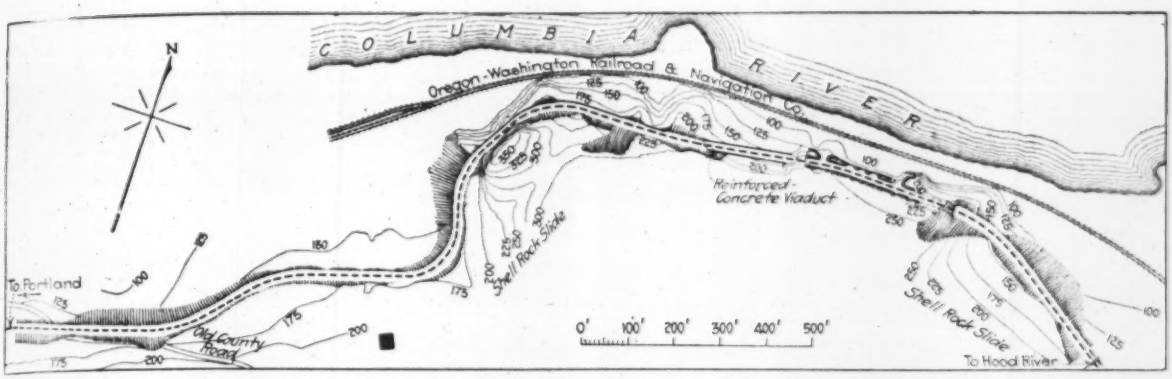

FIG. 3. TOPOGRAPHIC PLAN OF COLUMBIA RIVER HIGHWAY, HOOD RIVER COUNTY, SHOWING STORM CLIFF TUNNEL

issue of $75,000, the proceeds of which were to be used in making the highway passable to the City of Hood River. The bond issue was carried on July 15, 1914, by a vote of 1,502 to 425.

On Mar. 22, 1915, a contract was entered into by the State Highway Commission with the Standifer-Clarkston Co., of Portland, Ore., to build this 3,000-ft. stretch of the Columbia Highway around Mitchell's Point.

The accompanying map shows the topography of the country, and the road as constructed. During construction it was found necessary to make the concrete viaduct 208 ft. long and the tunnel proper only 390 ft. in length.

TABLE 1. FINAL ESTIMATE OF THE CONTRACTOR

4.86 acres clearing @ $90	$437.40
82 sq.rd. grubbing @ $2	164.00
4,284 cu.yd. earth excavation, hauled 0 to 300 ft., @ 24c	1,028.16
3,734 cu.yd. earth excavation, hauled 30 to 1,000 ft., @ 27½c	1,026.85
2,394 cu.yd. hardpan excavation, @ 45c	1,077.30
1,362 cu.yd. loose-rock excavation, @ 47c	640.14
7,731 cu.yd. shell-rock excavation, @ 30c	2,319.30
8,898 cu.yd. solid-rock excavation, hauled 0 to 300 ft., @ 77½c	6,973.45
7,057 cu.yd. solid-rock excavation, hauled 300 to 1,000 ft., @ 81c	5,716.17
160.25 cu.yd. rubble masonry, @ $10	1,602.50
339.88 cu.yd. Class "A" concrete*, @ $15	5,098.20
45.1 cu.yd. Class "C" concrete†, @ $9	405.90
48,669 lb. reinforcing steel, @ 3½c	1,703.41
409 lin.ft. concrete railing, @ $1.50	613.50
74 lin.ft., 12-in. concrete pipe, in place, @ $1.50	111.00
390 lin.ft. tunnel excavation, @ $33	12,870.00
30.6 lin.ft. tunnel-window excavation, @ $30	918.00
119.2 cu.yd. solid-rock overbreak, @ $3	357.60
Extras, force account	1,415.08
Total	$44,477.96

* Class "A" concrete consists of 1 : 2 : 4 mix. † Class "C" concrete consists of 1 : 3 : 6 mix.

TABLE 2. COST OF THE TUNNEL PROPER*

390 lin.ft. tunnel excavation, @ $33	$12,870.00
30.6 lin.ft. tunnel-window excavation, @ $30	918.00
119.2 cu.yd. solid-rock overbreak, @ $3	356.60
20.79 cu.yd. rubble masonry in railways, @ $10	207.90
5.74 cu.yd. Class "A" concrete, @ $15.99	86.10
Force account, cementing cracks over portals	33.23
Total	$14,472.83
Length of tunnel, ft.	390
Cost per lin.ft.	$37.10

* The cost of the tunnel proper includes windows, concrete railings, and a trail rom one window to a point on the face of the cliff, overlooking the outside of the tunnel.

TABLE 3. COST OF THE CONCRETE VIADUCT

390 cu.yd. Class "A" concrete, @ $15	$4,500.00
45.1 cu.yd. Class "C" concrete, @ $9	405.90
409 lin.ft. concrete rail, @ $1.50	613.50
48,400 lb. reinforcing steel, @ 3½c	1,694.00
355 cu.yd. shell-rock excavation, @ 30c	106.50
Force account, covering extra excavations for foundations for columns, and placing an expansion joint in the viaduct	1,230.38
Total	$8,550.28
Length of viaduct, ft.	208
Cost per lin.ft.	$41.10

The tunnel section is 18 ft. wide with vertical sides 10 ft. high. The heading is semicircular, having a radius of 9 ft. As originally planned, there were to be seven windows, but during construction it was found best to relocate them at certain places, and only five were cut through to the face of the cliff. The windows are approximately 20 ft. wide and 19 ft. high.

The specifications provided for a bonus to the contractor for careful work. It was provided that payment should be made at so much per lineal foot for the neat tunnel cross-section. The contractor was allowed to make the tunnel at any point 5% by area less than the neat cross-section and receive payment for the full cross-section. He was also permitted to make the tunnel at any cross-section larger by 10%, and the payment made at the overbreak was at the same rate of $3 per cu.yd. If, however, the tunnel cross-section at any point was made larger in area than 10% in excess of the neat cross-section, no payment was made for the overbreak, and the contractor received only the amount of his bid per lineal foot for tunnel excavation. In all cases measure-

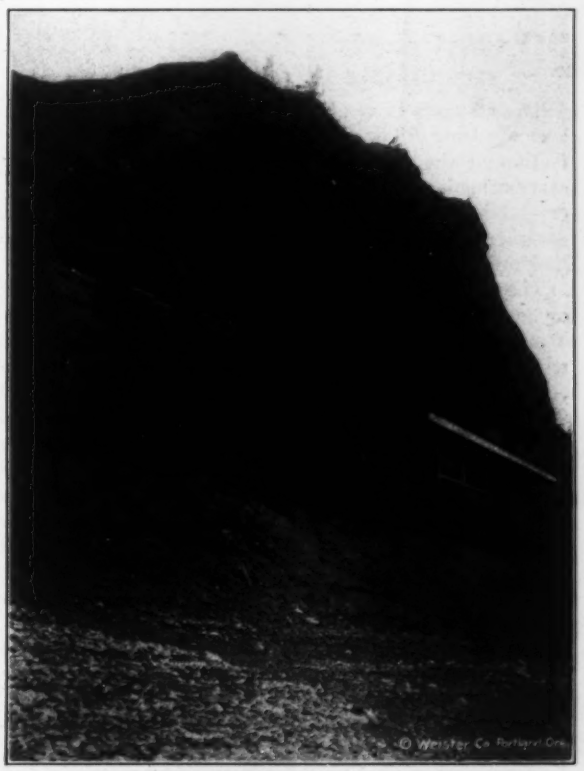

FIG. 4. STORM CLIFF OR MITCHELL'S POINT TUNNEL, COLUMBIA HIGHWAY

ments were made for the rectangular portion of the tunnel cross-section from the vertical median line and for the tunnel heading from the center of the semicircle.

No lineal dimensions were permitted less than 5% nor greater than 10% over the dimensions required for the neat cross-section. The excavation of the windows was made under similar specifications.

Fortunately the contract was awarded to a very good firm of contractors, who took a great deal of pride in the work, with the result that a job with an excellent finish was obtained. Work was begun Mar. 31, 1915, the road was opened Sept. 6, 1915, and work was completed Nov. 10, 1915.

The contractor's final estimate, the cost of the tunnel proper and the cost of the concrete viaduct are given in the accompanying tables.

The cost of the portals, being work similar to solid-rock excavation, was paid for as such and has not been included in the tunnel cost. The west portal, next to the viaduct, cost $175.15, and the east portal cost $3,969.98.

The view from the tunnel windows, looking down upon the tracks of the Oregon & Washington Railroad and Navigation Co. and out over the Columbia River into the State of Washington, is superb.

This project was planned, surveys made, estimates prepared and the contract let under the direct supervision of the writer, while State Highway Engineer of Oregon. It has been completed under the administration of the present Highway Engineer, E. I. Cantine. J. A. Elliott was locating engineer, had charge of the preparation of the estimates and was district engineer in charge of construction of the project to completion.

Strengthening the Cairo Bridge on Illinois Central R.R.

The strengthening of the Illinois Central R.R. bridge over the Ohio River at Cairo, Ill., is an interesting illustration of the possibility of adapting an old bridge to carry a loading much heavier than that for which it was designed. The Cairo bridge was built in 1887-88, the designer and consulting engineer being the late George S. Morison.

The trusses were proportioned to carry a moving load of 3,000 lb. per lin.ft.; but in calculating the effects of a moving load, the part of any strain in excess of that which would have been produced by a uniform load of equal amount was taken on a basis of 5,000 lb. per ft. The top lateral system was proportioned to resist a wind pressure of 300 lb. per lin.ft., and the bottom lateral system 500 lb. per lin.ft. The floor system was designed for a uniform load of 6,000 lb. per lin.ft. The compressive strain in the top chord was limited to 14,000 lb. per sq.in. of balanced section. The tensile strain in the bottom chord was limited to 13,000 lb. per sq.in., and that in the web members was kept somewhat lower (*Engineering News*, Feb. 7, 1891, and Jan. 11, 1906).

The bridge consists of 34 spans—2 through spans of 518 ft. with double-intersection trusses, 7 similar spans of 400 ft., 3 deck spans of 249 ft., 21 of 150 ft. and 1 of 106 ft. All are of the Pratt type. The weight of the spans is 1,032 tons for each 518-ft. span, 567 tons for the 400-ft., 235 tons for the 249-ft. and 100 tons for the 150-ft. spans. The total length at present is 3,882 ft. for the bridge proper, and 20,461 ft. inclusive of the approaches (steel spans and earth embankment). The rail level is 110 ft. above low (or 55 ft. above high) water.

The substructure consists of stone and concrete piers, the foundations for which were put down by the pneumatic process. The caissons were sunk to a depth of 75 ft. below low water, in a formation of sand and gravel. No alterations were necessary in connection with the strengthening of the superstructure.

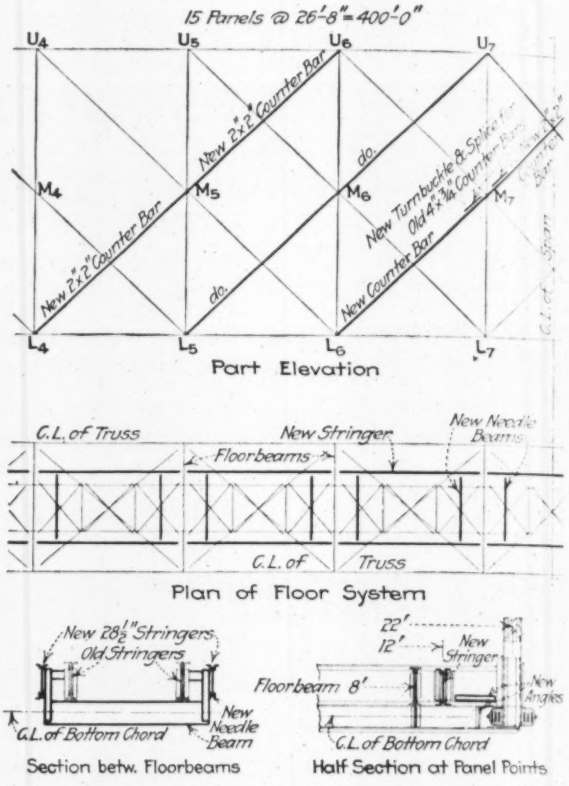

FIG. 1. REINFORCEMENT OF TRUSSES AND FLOOR SYSTEM IN THE 400-FT. SPANS OF THE CAIRO BRIDGE

Alterations to the Cairo Bridge

The bridge originally had long approaches of steel deck-truss spans on both sides of the river. Owing to the heavy traffic and the double-tracking of the line on each side, it was proposed in 1903 to double-track the approaches and also to build a new double-track superstructure across the river. The reconstruction could have been carried out by extending the piers or by capping them with bearing girders of sufficient length to carry the new bridge seats. This work was not done, except that the steel spans of the Illinois approach were replaced by a double-track embankment, leaving only a 52-ft. girder span and two 249-ft. truss spans between the fill and the 518-ft. channel spans.

Apart from the increase in traffic capacity it was necessary to provide greater strength in the bridge, to accommodate the weight of modern locomotives and trains. This work was carried out during 1914 and 1915. It was done with company forces, using the regular equipment of the bridge gangs. Owing to the great length of the structure, the work was spread out to a considerable extent, and four air-compressor plants were in use

for the riveting. All work was done between trains, and there was very little interruption to traffic.

The bridge as now strengthened provides for a live-load of one 230-ton 2-8-2 locomotive followed by 80-ton loaded cars (55 tons' load per car). The design and execution of the reinforcement were under the direction of A. S. Baldwin, Chief Engineer, Illinois Central R.R., and F. L. Thompson, Assistant Chief Engineer.

Strengthening the Truss Spans

The trusses of the through spans were strengthened by the addition of counters consisting of square bars 2x2 in. Each bar was attached to the pin at the the lower chord, and at the center of the post by means of U-shaped bars with clevises. At the top chord the connection was a stiff bracket riveted to the under side of the chord and the face of the post, the counter being attached to this bracket by means of a clevis and pin. This arrangement is shown in Figs. 1 and 2.

The floor system of the 250-ft. deck spans and of the longer through spans was reinforced by placing additional stringers outside of the original track stringers. At the quarter points of each panel, transverse needle beams beneath the floor were suspended from the new stringers. These beams had shoes beneath the old stringers, and by means of wedges the latter stringers were brought to a bearing on the shoes. In this way the effective length, or span, of the old stringers was reduced.

In the 518-ft. spans the new stringers are 30½-in. plate girders 30 ft. 3¾ in. long. The web plate is 30x ⅜-in., and the flange angles are 6x3½x¾ in. On account of the hangers for the needle beams the bottom inner flange angle is omitted and a bar 6x½ in. is used in its place (Fig. 2). The needle beams for these spans are 20-in. 60-lb. I-beams.

It was desired to have the new stringers of uniform length, so far as possible, in order to permit of their easier erection, and also to meet the variation in distance between the faces of the floor beams, filler plates of different thicknesses were supplied, to be placed between the ends of the stringers and the webs of the floor beams.

The 150-ft. and 106-ft. deck spans were reinforced by adding a pair of 24-in. I-beams beneath each track stringer, the latter resting on 7x16-in. wooden blocks 28 in. long, which were laid across the I-beams at the third points of each panel. The light top lateral rods, which had been kept in adjustment with considerable difficulty were replaced by rods of heavier section. Sway bracing was added in the vertical plane of the truss posts. The deck stringers and bracing are shown in Fig. 3.

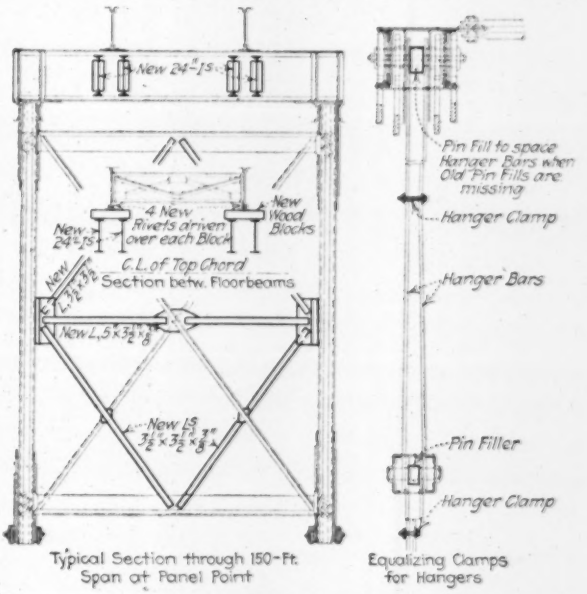
New 24"-15
4 New Rivets driven over each Block
New Wood Blocks
C.L. of Top Chord
Section betw. Floorbeams
New L 5"x3½"x⅞
New L5 3½"x3½"x⅞
Typical Section through 150-Ft. Span at Panel Point
Pin Fill to space Hanger Bars when Old Pin Fills are missing
Hanger Clamp
Hanger Bars
Pin Filler
Hanger Clamp
Equalizing Clamps for Hangers

FIG. 3. REINFORCEMENT OF 150-FT. SPANS AND METHOD OF EQUALIZING STRESSES IN HANGER BARS

All adjustable members of all the spans had been provided with closed sleeve nuts. As the threads in many of these nuts were in bad condition, it appeared that it would be impossible to maintain proper adjustment and that a dangerous condition might result. A detail was devised therefore whereby the sleeve nuts were adjusted and a rigid splice connection then placed over them, thus converting the member from an adjustable to a rigid member. This construction is shown in Fig. 2.

In many of the vertical hangers consisting of two bars it was found that the adjustment in the bars was not uniform. To correct this defect, a clamp was applied consisting of two flat bars connected by bolts (Figs. 2 and 3). This method proved to be a very effective way of equalizing the adjustment in the two bars.

Field measurements were taken in all cases, and no trouble was experienced in fitting the parts in place.

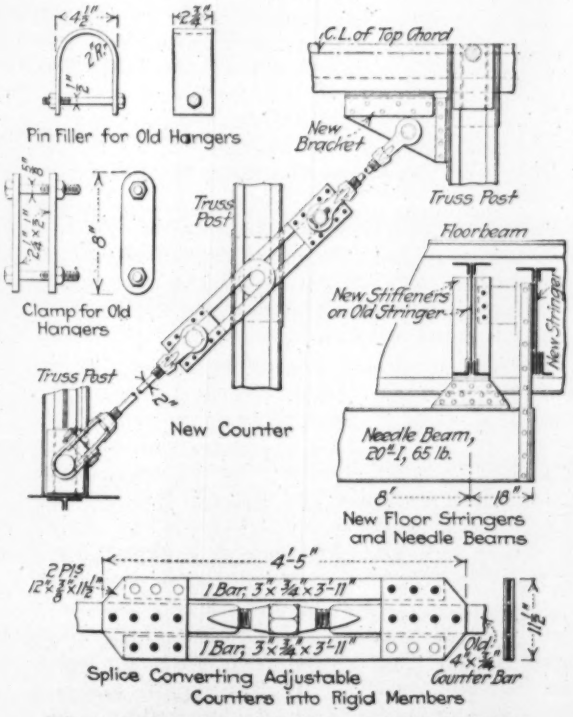

FIG. 2. DETAILS OF BRIDGE REINFORCEMENT

The Chicago Railway-Terminal Problem is again to be taken up by the city with a view to the concentration of the present passenger-terminal stations. Under ordinances passed some time ago the Illinois Central R.R. is required to build a new terminal station on a site adjacent to the present station, in order to make way for the extension of 12th St. to the lake front and for the improvement of Grant Park. The council committee on railway terminals has now been directed to confer with the several railways entering from the south in order to determine upon the exact location of the new Illinois Central R.R. terminal and to provide for its use by other roads which now run beyond 12th St. and use the Dearborn, La Salle and Grand Central terminal stations.

Tile Drainage by Day Labor and by the Rod

SYNOPSIS—Drainage system for farm lands, on Mississippi River, being built under supervision of engineers. How the concrete drain tile is made; costs of pipe. Work done both by day labor and by piecework. Prices paid per rod.

The system of tile drainage for an area of about 1½ sq.mi., which is shown in Fig. 1, is designed for the complete or intensive farm drainage of land already provided with ditches for general drainage. Landowners and farmers are coming to realize the value of this kind of work in maintaining the land in good condition for agricultural use. What is still more important, they are coming to realize the necessity of carrying out the work in a comprehensive manner instead of each man building a small tile system for himself, to discharge the water onto adjacent land that may or may not be drained.

The section referred to is a part of the Bay Island Drainage and Levee District, in Mercer County, Illinois. The district has an area of about 33 sq.mi. and is protected from the Mississippi River by a levee along the west side. Its dredged ditches have a flow to the south and are intended to drain the lakes and sloughs. At the outlet of the main ditch the water is pumped over the levee into the river.

Some tracts of land within the district have scattered lines of tiling for individual drainage, but these are not laid out in a comprehensive system and are quite inadequate for thorough drainage. The aim in these cases has been merely to drain low spots; so while the open ditches are of some use in a dry season, they are practically useless in dealing with water coming from adjoining lands or with the overflows from the lakes.

The section shown on the map includes tracts of land owned independently by the Mueller Lumber Co., Dr. Bomke and Ziegler Brothers, but its drainage is planned as one comprehensive system. The boundaries of the drainage area were determined and the main drains then located through the low points. The laterals are spaced uniformly 100 ft. apart. In the area of 1½ sq.mi. there will be about 75 mi. of 6- to 22-in. tile, with two 22-in. and eight 12-in. outlets into the open ditch.

The runoff is taken as ½ in. in 24 hr., this rather high figure being used as there is some seepage from the river during stages of high water. The soil is rich loam, with clay subsoil and some streaks of sand.

Trenches for Tile Drains

The trenches will be 3½ to 7 ft. deep. The excavation is done by hand, each trench being commenced at its lower end. The lines are staked out and the trenches excavated about 10 in. from the stakes. The top soil and clay are thrown out on opposite sides. Care is taken not to cut below the grade line, and the bottom of the trench is grooved and shaped to receive the tile and hold it in position.

In connection with the excavation it was required that all stumps, trees and brush within 30 ft. of the drains should be removed. The specifications called for grubbing out the roots to a depth of at least 3 ft. Different plans were adopted, however, by which a portable saw is used for cutting the trees, and stumps are blown out with dynamite where necessary, as shown in Fig. 2. The wood is either burned, or stacked for future use.

To give the grade, transverse frames are erected at the grade stakes, over which a cord is stretched above the center line of the ditch and at the required grade. This is shown in Fig. 2. These supports must be kept erected for at least three grade stakes and the work checked by sighting over them. Intermediate supports are placed to support the cord at about 50-ft. intervals, carefully lined in by sighting.

Concrete pipe is used. It is in lengths of 12 in. for pipe 12 in. in diameter and under, 18 in. for 15- and

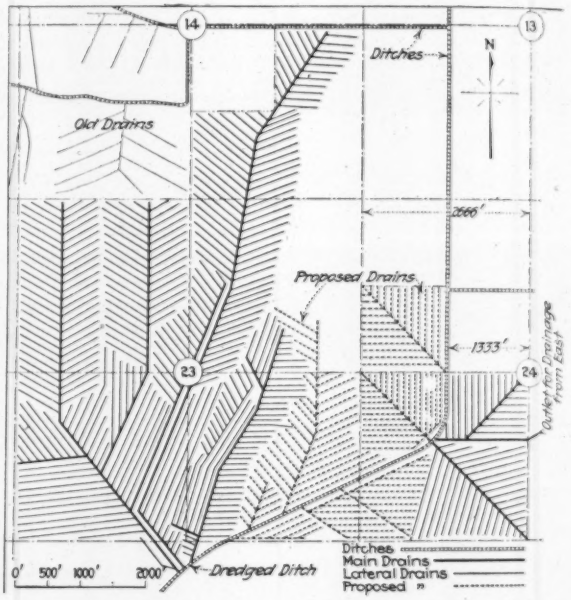

FIG. 1. MAP OF A TILE-DRAINAGE SYSTEM IN ILLINOIS

18-in. pipe, and 30 in. for 22-in. pipe. The laying is commenced at the lower end of each drain. In putting in the pipes they are placed until the top of the joint is closed, except that in sand or fine silt the bottom of the joint must be laid close to prevent the material from entering. In the latter case the top of the joint is covered with clay. Where an opening of ¼ in. or more is left in order to make turns or on account of irregular tile, this gap must be covered with broken pieces of pipe. Fig. 2 shows ready for shipment some of the pipe, which is supplied by the Ziedler Concrete Pipe Co., of Muscatine, Iowa.

The pipe is made by a Schenk & Stewart revolving-process machine, using washed and screened sand and gravel graded in four sizes and obtained from the Northern Granite Gravel Co., of Muscatine, Iowa. A 4-min. mix is used. The temperature of the mix is maintained at from 80° to 90° F. After casting, the pipe is placed in a vapor room for 36 hr., the temperature being 110°.

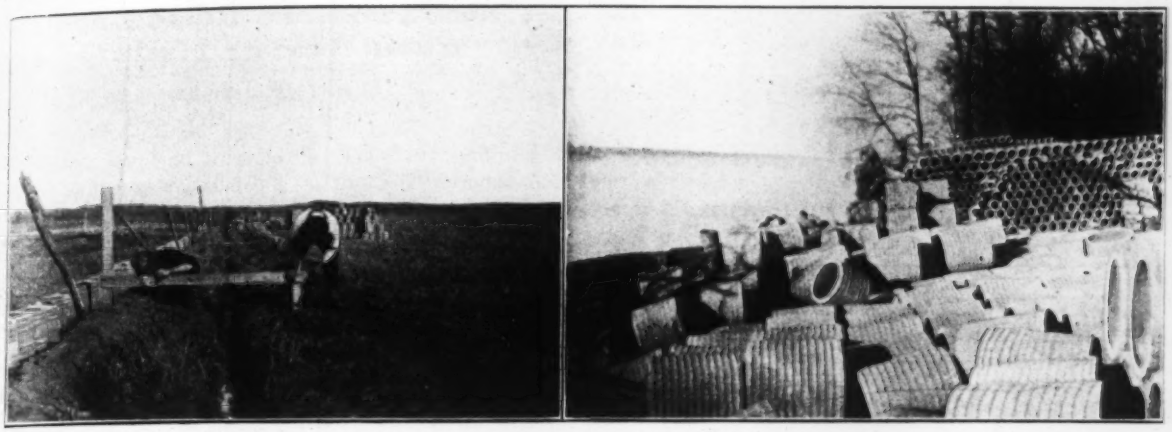

FIG. 2. TILE DRAINAGE IN THE BAY ISLAND LEVEE AND DRAINAGE DISTRICT IN ILLINOIS
Left—Setting the cord for line and grade. Right—Concrete tile

The cost of the pipe per thousand feet, f.o.b. Muscatine, is $17.50 for 4-in., $22 for 6-in., $42 for 7-in., $52 for 8-in., $72 for 10-in. and $94 for 12-in.

After the drain has been inspected and its grade checked, the pipe is covered, or blinded, with about 6 in. of clay before backfilling. When the pipe is secure and the soil favorable, this blinding may be omitted; but in no case is sand allowed to be filled directly upon the tile. The backfilling is done by hand.

Engineering and Organization

The work is being done mostly by piecework, under the direction of the Central States Engineering Co., of Muscatine, Iowa, of which C. H. Young is Chief Engineer. It constitutes a joint job for the three owners already mentioned, who deal directly with the chief engineer. It was intended originally to do the work by the rod or day, but the plan was abandoned in favor of piecework. The tile is hauled both by day labor and by the ton, the company building necessary roads and bridges from the river bank to the site. Clearing is done by the day and by the acre, the company furnishing dynamite and a small portable sawmill. The temporary pumps are operated by the company.

The engineer in charge in the field has full authority to lay out and direct the work and supervise the construction. He has charge over the timekeeper, the general foreman and his crew, the cook and his assistants. He directs the placing of material, boarding and lodging the men, setting grades and line, etc. He countersigns all pay-checks and approves all bills. A checking account is placed at his disposal for unforeseen emergencies and for paying off employees in case of discharge. He determines the number of men to be employed to carry on the work properly and has authority to discharge any employee.

The timekeeper keeps the time, makes out payrolls, takes care of the commissary and generally assists the engineer. The general foreman has charge of the laborers (both on the work and in the bunkhouse). He signs the teamsters' haulage tickets and keeps a check list of his men. He has authority to employ or discharge laborers, but the number of men to be engaged at any time is determined by the engineer in charge.

Men hauling material (whether by the day, load or ton) must secure from the timekeeper a ticket showing the number of pieces of each size of pipe hauled along the ditch, payment being made only on the basis of these tickets, which are described later. At present nearly all the tilers are employed by the rod, as the men will work harder and make more money if there is some inducement. The overhead expenses and distribution of material are handled by the day.

The pay of this working organization is as follows: Engineer in charge, $7 per day and expenses; timekeeper, $50 per month, with board and lodging; general foreman, $90; cook, $60; cook's helpers, $35. For hauling material a uniform rate of $1 per ton has been agreed upon by the employers, who undertake to deliver material along the trenches on their respective properties.

Costs and Accounts

The question of ditching by machine was considered, but the cost by this method promised to be high. The soft ground made it necessary either to wait until the swamp was frozen or to mount the ditcher on skids. Bids were called for, but the contractors did not seem enthusiastic over the job; they wanted to lease their ma-

Daily Report

CAMP ZEIGLER STATE DATE 191

Occupation	Name	Excavation					Amt.	Location					Hrs.	Pipe			Misc.	Meals	Supplies		Remarks
		Hrs. Tiling	Hrs. Bottom	Rate Per Rod	Rate Per Day	Rate Per Mo.		System	Sub. Main	Lateral	Station From	Station To	Backfill	Hauling Pcs.	Size	Ton		No.	Amt.	Item	

FIG. 3. FORM OF DAILY REPORT FOR TILE-DRAINAGE WORK

chines at a definite rate. Following are the prices in cents paid per rod and the width of the trench in inches:

	6-In.	Width of Ditch	8-In.	Width of Ditch	10-In.	Width of Ditch	12-In.	Width of Ditch	15-In.	Width of Ditch	18-In.	Width of Ditch	22-In.	Width of Ditch
Topping....	12	5 14	12	5 14	15	0 20	15	0 20	17	0 22	20	26	35	31 5
Bottom....	22	5 14	22	5 14	32	5 20	37	5 20	45	0 22	55	26	67	31 5

Overdepth paid for at 1.5c. per in. of depth.

These prices are computed on the maximum basis of 2.5c. per in. in width of ditch for bottom work and 1c. per in. of top width of ditch. An 18-in. spade depth is given as the depth for topping and bottom work. As the digging was easy, the prices were reduced slightly, so that a 14-in. ditch, for example, on topping cost 12.5c. instead of 14c. The price will not exceed 2.5c. for bottom and 1c. per top.

CAMP ZEIGLER Date..... 191....

Mr..... Teamster.....

	Pcs.	Size	Tons	System	Lateral	From	To	Remarks
1st Load								
2nd Load								
3rd Load								
4th Load								

TOTAL_____ Amt. $_____

By _____

FIG. 4. FORM OF HAULAGE TICKET

The pipe is floated about 10 mi. down the river on barges and distributed by wagons, the average haul being 2½ mi. Much of it will be distributed during the winter while the ground is frozen. For the working forces a camp has been built, with bunkhouses, messroom, etc. About 40 men will be employed when work is in full swing.

The expense accounts are divided under five general classifications—materials, construction, board and lodging, small contracts, engineering. The blank forms used in keeping the records were designed specially for this work. The daily report, Fig. 3, is 10¾ in. wide and 7½ in. high. The haulage ticket, Fig. 4, is 3x6 in., and the payment order, Fig. 5, is 5½x5½ in.

CAMP ZEIGLER Date.....

Mr.....

Please give Mr..... .....

the following amount for:

Topping.....rds. at.....$.....between station.....and station.....
.....on.....system.....lateral.

Topping.....rds. at.....$.....between station.....and station.....
.....on.....system.....lateral.

Topping.....rds. at.....$.....between station.....and station.....
on.....system.....lateral.

Bottom.....rds. at.....$.....between station.....and station.....
on.....system.....lateral.

Bottom.....rds. at.....$.....between station.....and station.....
on.....system.....lateral.

Bottom.....rds. at.....$.....between station.....and station.....
on.....system.....lateral.

Clearing trees for Mr..... .....at.....$.....

Hauling.....tons of tile at.....$.....

Labor for.....at.....hours.....$.....

Labor for.....at.....hours.....$.....

Deduction for board.....meals at.....$.....

" " Comissary.....$.....

.....
Timekeeper or Foreman

Received payment in full to date.

.....

(Signed)

FIG. 5. FORM OF PAYMENT ORDER

Water Pressure Raised and Waste Survey Made*

By Francis F. Longley†

St. John's, Newfoundland, has for some years past been troubled with deficient quantity and pressure in its water-supply. The city has a population of a little more than 30,000. It has taken its water-supply for many years past from four or five miles west of the city and about 500 ft. above sea level. From the easterly end of the lake a conduit extends about two miles to a basin. From this basin two pipe lines, mainly 16 in. in diameter, extend to the city by two different routes.

The most obvious defect in the entire system at the time we [Hazen, Whipple & Fuller] were invited to take up this study was the inadequacy of the distributing mains in the city. The water consumption averages about 6,000,000 U. S. gal. a day. The system is extremely weak in large mains, resulting in a great loss of pressure, especially at times of maximum consumption.

Winter conditions have always imposed a severe drain on the water-supply, as the construction of the houses and the design of the plumbing and the methods of heating in common use do not tend to prevent the freezing of the pipes within the houses, and the water is quite commonly permitted to run, to prevent freezing. The cold-weather draft of water, therefore, runs up very high, and at these times the pressure in the city has at certain times and certain places almost disappeared. Besides the reduction of waste, the thing that was obviously needed was a few main arteries that would carry the quantity of water demanded by the city to the most remote parts with a minimum loss of head. The work of laying these new mains went forward during the summer of 1915, and at the end of the working season most of the mains were ready to put into service.

Leakage and Pressure Tests

A series of tests were at that time made upon the improved system. The first was a leakage test. Some 8,000 ft. of 20- and 16-in. mains was tested under approximately the normal working pressure, and found to give a leakage not exceeding about 2 gal per min., indicating that the work had been well done. Then fire-stream tests were made, to show the improvement secured by the addition of these mains in the pressures over the lower part of the city.

As the system stood before the new mains were connected with the old ones, the pressure along Water St. was drawn down by 11 fire streams to about 36 lb. After the new mains had been connected to the old ones, 11 fire streams reduced the pressure to only 68 lb. The pressure that yielded four fire streams in the old system now yields ten streams; the pressure that yielded three fire streams in the old system now yields eight; the pressure that yielded two fire streams in the old system now yields six. Further benefits will follow the laying of the additional supply main from the source and the connection with the new service reservoir.

The intake of the system at Windsor Lake is quite inadequate. One of the most serious intake difficulties

*Condensed from a paper read before the New York Section of the American Water-Works Association, New York City, February, 1916.

†Of Hazen, Whipple & Fuller, Consulting Engineers, 30 East 42rd St., New York City.

...th ice. In order to eliminate these difficulties and to provide means for maintaining an adequate supply under all conditions, plans have been made for a new ... of 36-in. steel pipe extending some 600 ft. more or less into the lake.

In the past the city has had no means of measuring the quantity of water used. Some measurements were made for the first time in the fall of 1914, by means of a weir. Plans have been made for a venturi meter, gate house and connections, which will afford complete means for the measurement and control of the flow.

St. John's has had no service reservoir in the past, depending upon the flow through the long supply lines to take care of the maximum as well as the ordinary draft. A natural lake, known as George's Pond, lies in an admirable location and at a most suitable elevation for a service reservoir. George's Pond has an area of about 13 acres and a good depth. It lies at an elevation slightly higher than 300 ft. above sea level and at a distance of only a few thousand feet from the eastern end of the city. The elevation of the pond is such as to give good pressure for domestic and fire service along the waterfront and for a considerable distance back into the city, and it gives hydraulic conditions that fit in well with the elevation of the main supply.

A 20-in. pipe is being laid to this pond from the mains in the city, thus affording an economical arrangement for a large reserve supply close to the city and securing also a considerable saving in the capacity required in the main supply lines to take care of the maximum demand.

Night Tests Show Great Waste of Water

The weir measurements that were made when this study was first taken up indicated that during that period of a week the average rate at which the water flowed to the city was 6,360,000 U. S. gal. per day, representing a per capita consumption of about 200 U. S. gal. The minimum rate during the 24 hr. was over 80% of the maximum. There are but few manufacturing or commercial establishments that consume any considerable quantities of water regularly at night, and it is therefore probable that the waste is constantly going on day and night at a rate somewhat approaching the observed night flow.

Much of this large amount of waste could be detected and eliminated, if the problem were properly attacked. The most effective way of getting at this would be by meters. Their use was recommended.

From the magnitude of the waste it appeared that something might be done rather rapidly to indicate where the loss mainly occurred, by means of a subsurface study of the distribution system. We therefore undertook to isolate various parts of the distribution system and to get a rough measurement of the night flow into such districts, assuming this night flow to represent approximately the leakage therein. Suitable equipment for convenient and accurate measurement was not at hand, and it was therefore necessary to improvise a method with the material available. The first plan was simply to connect a hydrant within the isolated district to one outside, through a fire hose of known length and diameter, and to measure the drop in pressure between the two hydrants, making proper corrections for differences in elevation. The quantity flowing was then roughly estimated from the friction loss through this hose. This procedure was obviously a preliminary step only, but it resulted in showing in what districts to look for large waste, and it gave a rough approximation of the quantity of leakage therein.

Later, a meter was inserted in the hose line. Careful observation of the meter gave indications of changes in the rate of flow, and this method was used to follow up the first method. The isolated district was then reduced in size by successively closing all available gates, while the meter was under continual observation, and this resulted in a much closer localization of the waste.

From these rather rough methods it was made clear that from 75 to 80% of the total night flow in the districts examined was on the house services and only 20 to 25% on the mains. This determination, of course, was followed up as vigorously as possible by a house-to-house inspection and produced results that have encouraged the city to plan further and more thorough work along similar lines.

The apparatus employed for use in waste reduction consists of two small venturi-meter tubes—one 3x1½ in., the other 2x⅝ in.—erected on the same stand and connected by suitable pressure pipes and valves to a monometer with two scales, one for each of the meter tubes. By means of this apparatus inserted in the hose line connecting two hydrants, one within and one outside the isolated district, very small changes in rate of flow into the district may be observed, yielding information that will permit the elimination of even small amounts of waste on the various services.

Engineering Ethics

That engineers are wage earners and must organize if they are to improve their condition was a view taken in the report of a special committee on professional ethics and standard fees, presented at the annual meeting of the Iowa Engineering Society at Des Moines, Iowa, Feb. 17, by K. C. Gaynor, of Sioux City, Iowa.

It was stated that the codes of ethics of the American Society of Civil Engineers and the American Institute of Architects are well and good for men in consulting work, but that they hardly apply to the much larger number of men in ordinary practice or working for a salary. Probably 90% of the members of the engineering profession work for a wage or salary, while 90% of those of the legal and medical profession work for a fee. Engineers on extensive and costly drainage projects in Iowa work for $5 to $7.50 per day, which is about what a good bricklayer gets. It was suggested that the organization of the American Association of Engineers indicates a recognition of the fact that engineers as a whole form a laboring class.

Another difficulty is that many engineers run contrary to the fundamental principles of ethics or right action. Thus a city engineer, county engineer or college professor, having a sure salary sometimes takes outside work at a price lower than the standard in the community and lower than other engineers can afford. Many material and supply firms also offer free advice and engineering assistance. All this action lowers the price of engineering work and lowers the standard of engineering and can be fought only by publicity.

According to the report, wage-earning engineers must organize if they wish to accomplish any improvement in their condition. If they are too proud to organize, they will have to get along as best they can.

Some Recent Legal Decisions of Interest to Engineers

Municipal Authority to Erect Poles and Wires—The New York Public Service Commission has been recently overruled by the New York Supreme Court in its refusal to grant to the Niagara & Erie Power Co. permission to construct and maintain a power plant in the town of Portland. The power company had made application to the Portland town board to construct poles and wires within the town. The permission was granted. The company then petitioned the Public Service Commission for permission to construct its plant in the town. This was denied upon the sole ground that the company had not obtained consent of the town superintendent of highways. The commission took the position that the New York transportation law requiring the consent of the "municipal authorities" placed a duty upon the corporation to secure the consent of the highway superintendent. The Supreme Court in overruling the Public Service Commission (Farnsworth vs. Boro Oil and Gas Co.; 156 N. Y., 879), said:

> The question before us is, Who are the "municipal authorities" of a town within the meaning of this expression? The truth is, very likely, that the legislature did not have any particular official or body in mind. It is simply one of those careless, indefinite expressions which so frequently creep into statutes. But it is not so important in this case to discover the legislative intent as to avoid a conflict of authority when applications like the one before us are made. It is desirable that the responsibility of granting or refusing applications for franchises of this nature in towns be definitely fixed and placed upon some specific body or official.
>
> This question has never been directly passed upon by the courts, so far as we can discover, although there have been several expressions pro and con. The latest, highest and most authoritative expression shows clearly that the Court of Appeals considered that the town board is the "municipal authorities" intended by the statute.

Purchaser Using Machine That Fails to Meet Test Must Pay for It—A contract for the sale of an engine contained certain guaranties and provided for an endurance test, by means of which the engine should be shown to possess the qualities specified, and that, if the engine did not fulfill the test or satisfy the guaranties, the purchaser should not be required to pay therefor, and the engine should be forthwith removed. The test left the question whether the engine fulfilled the guaranties in dispute, and the purchaser, though continuing to use the engine, refused to accept it or pay for it.

An action was brought for the price of the engine by the manufacturer, and it was held that a recovery for the purchase price should be allowed. Although the engine failed to meet the test to which it was subjected, the court held that the continual refusal of the purchaser either to accept or return the engine made him liable for the purchase price. Keeping and using the engine caused title to pass to him, and from that time the guaranties ceased to be conditions precedent and became collateral agreements, for the breach of which the purchaser was confined to a recoupment of damages, as his conduct in continuing to use the engine was conclusive evidence that the engine was a substantial performance of the contract. (Crescent Milling Co. vs. Straight Manufacturing Co.; 225 Fed., 808).

Operation of Telegraph Lines Over Post Roads—A telegraph company that has accepted the provisions of the acts of Congress giving the right to construct, maintain and operate telegraph lines over and along any of the military or post roads of the United States is protected by that act against exclusion or other arbitrary interference by a town whose authorities, with full knowledge of all the circumstances, permitted the location and construction of such lines along the highways and for more than 20 years acquiesced in their maintenance and operation, although the telegraph company was never granted the formal antecendent permit contemplated by state law "specifying where the posts may be located, the kind of posts and the height at which and the places where the wires may run." (New England Telegraph Co. vs. Massachusetts; 36 Sup., 103.)

Creosoting Wood Blocks in Vertical Tanks

By E. A. Sterling*

A comparatively new idea in the process of creosoting wood block has been developed, which is of great importance to the lumber industry, because it promises to reduce the cost of wood blocks materially. This idea is mainly one of economy in operation and does not involve any new or untried methods of impregnation or preservative material. Two engineers, working independently, evolved practically the same fundamental idea in the matter of vertical treating cylinders. The first to design and build a plant of this character was J. B. Card, Chicago, followed by G. B. Shipley, Pittsburgh, who is more recently in the field with a new plant embodying all the improvements and advantages that present experience makes it possible to apply to the vertical-cylinder idea. This plant is described herewith.

The vertical wood-block cylinders at Orrville were installed by the Ohio Wood Preserving Co. in conjunction with its horizontal cylinder, which is of the usual type for treating ties and other classes of material. Each type of cylinder is equipped for the use of any standard process using either creosote or zinc chloride; but because of the greater economy through the elimination of the wood-block cages necessary in the horizontal cylinder and the mechanical handling of the blocks from the planing mill to the cars, the vertical cylinders have been devoted so far entirely to wood-block treatment. The boiler house, horizontal-cylinder building, vertical-cylinder equipment, planing mill and shop are all housed in separate buildings. Steam is generated in two boilers of 150 hp. each, with steam at 100 to 150 lb. working pressure, and so fitted that coal, wood, refuse or gas can be used as fuel at any time. Electric current is furnished by a local power plant, and all the wood-working machinery is driven by direct-connected alternating-current motors, while the crane is driven by direct current.

The vertical cylinders for treating paving blocks are of two sizes, one holding 300 yd. and the other 200 yd. Each cylinder is fitted on the inside with a hydraulic plunger and platform so that, when empty and about to be charged with wood blocks, the platform is at the top. As the blocks are delivered into the tank, the platform lowers gradually, thus preventing breakage. When the cylinder is full, the top cover, or door, is put on; and the blocks are treated in the usual manner. After treat-

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machine when the cover is taken off and the plunger started, the blocks are forced up and discharged into a chute that leads directly into cars for shipment.

The advantages of treating wood blocks in a vertical type of cylinder may be summarized as follows:

1. Reduction in labor, owing to the mechanical handling of the blocks from the saws to the outbound cars.
2. Lost space is reduced to a minimum, permitting in each charge more cubic yards of blocks per unit of cylinder displacement than is possible in a horizontal cylinder, where block baskets or cages are necessary.
3. The vertical cylinders require only one-tenth of the ground space occupied by the horizontal plant.
4. The first cost of the entire equipment is materially less than that of a treating plant with horizontal cylinders.

Perhaps the chief advantage of the vertical-block plant from the standpoint of the lumber industry is its simplicity of operation and its low first cost. Only two machines are required and much smaller tanks and cylinders, thus permitting the construction of paving-block plants in connection with sawmills or near consuming points. Freight rates on shipments of blocks to remote territory may thus be eliminated, rendering it easier to meet the competition of other paving materials. In many localities the cost of wood blocks has been almost prohibitive on account of the long haul—a factor which can be largely eliminated if inexpensive vertical treating plants can be erected in regions that it is now possible to serve only from distant plants. Another consideration is that the capacity of the plant may be more readily fitted to the needs of the locality, the size and number of cylinders being readily adjusted or changed.

The vertical type of plant is also adapted to treat material other than blocks, so that local requirements may be taken care of or material treated for retail trade, such as silo stock, bridge material and farm timbers. The cylinders are operated by combined air compressor and vacuum pump, thus reducing all piping to a minimum. All measuring tanks are also vertical and mounted on weighing scales, so that the exact amount of preservative absorbed by the wood is determined directly instead of by the old volumetric measurements, which required temperature adjustment.

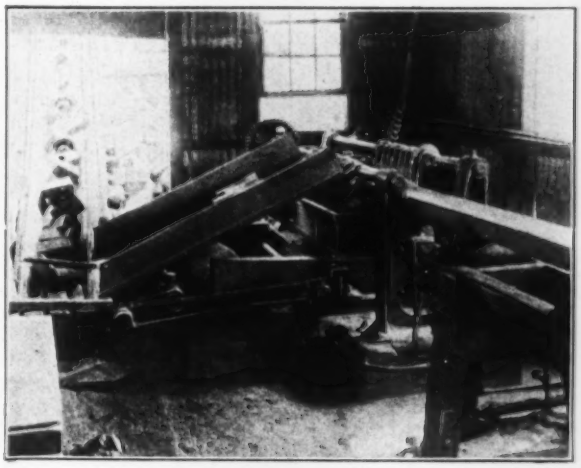

FIG. 2. WOOD-BLOCK SAW AND LOWER END OF AUTOMATIC CONVEYOR

The blocks are cut by an automatic band-saw (Fig. 2) running on ball bearings and driven by a direct-connected motor. The machine can be adjusted for different capacities, although it is generally used with eight saws, which easily cut 70 yd. of blocks an hour.

Another interesting feature of the Orrville plant, which has nothing directly to do with the wood-block treatment, is the use of a fireless locomotive for switching cars and tie trams in the yard. This locomotive operates by steam,

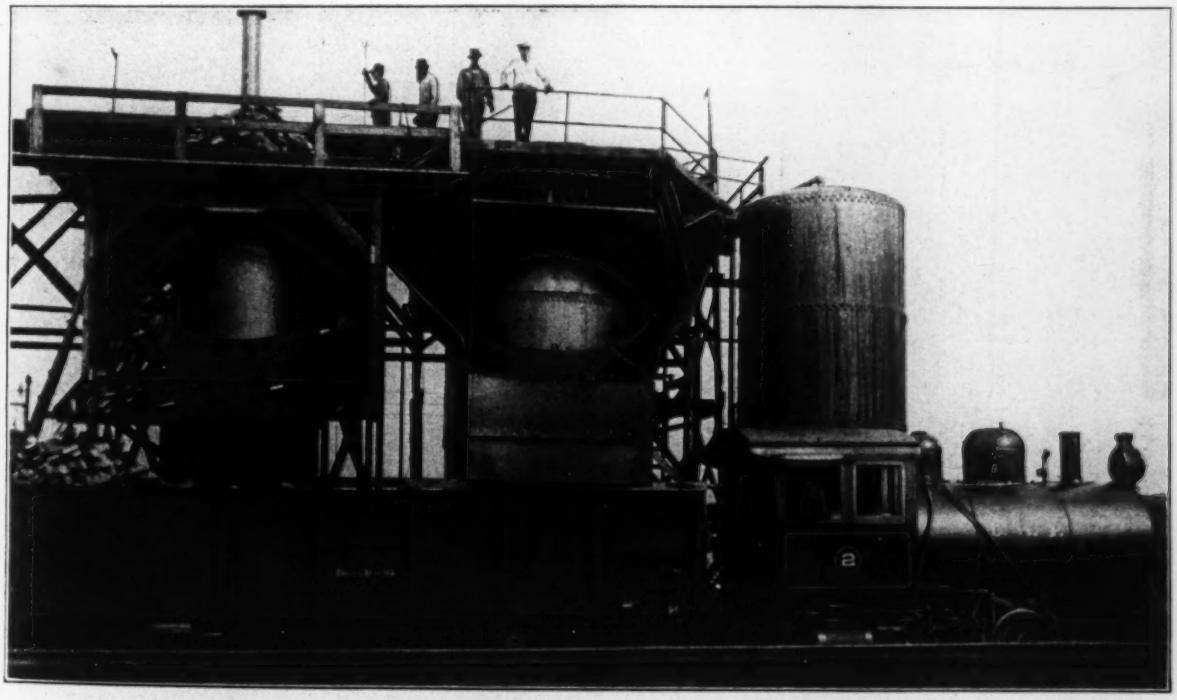

FIG. 1. CREOSOTED WOOD BLOCKS BEING EJECTED FROM VERTICAL TANKS AND LOADED INTO CARS DRAWN BY FIRELESS LOCOMOTIVE

the boiler being charged about seven times every 24 hr. at the main boiler, at 150 lb. pressure. The maintenance cost of this type of switching engine is low, and its use is very satisfactory in a treating-plant yard. Its tractive effort is fully equal to that of the usual type. Although it weighs only 22 tons, it has pulled as many as 12 loaded gondola cars at a time.

Qualifications for Membership in Engineering Societies

The principal requirements for admission to membership in each of the four great national engineering societies are set forth in the accompanying table, which has been compiled by Calvin W. Rice, secretary of the American Society of Mechanical Engineers. It will be seen that the requirements as to age and experience for full membership are about the same in the Mechanical, Civil and Electrical Engineers—namely, 10 years' experience and 30 to 32 years of age. Each of these societies has also a grade to which are admitted men of 25 to 32 years, who have had 5 to 6 years' experience, and also a grade for beginners in the profession.

These three societies have copied the practice of the British engineering societies, of which the Institution of Civil Engineers is the oldest, of grading those belonging to the society according to their age, experience and professional standing. The American Institute of Mining Engineers, on the other hand, was founded by men who had received their technical training in the famous mining schools of Germany; and it has always followed the practice of the great German Society of Engineers, which admits all members in one grade and makes no attempt to rate them according to their professional qualifications. One of the arguments in favor of this plan is that any grading of the members of a technical society is at best very imperfect. There are many engineers in the associate-member grade of the societies who are the superiors in professional ability of some of the men who hold full membership.

REQUIREMENTS FOR ADMISSION TO MEMBERSHIP IN VARIOUS GRADES IN FOUR NATIONAL ENGINEERING SOCIETIES.

	Mechanical Member	Electrical Fellow	Civil Member	Min... Mem...
Age	32 yr.	32 yr.	30 yr.	All professio... engineers, ...mining ...logists, metallurgi... chemists and all ...sons actively engag... in these branches of ...ineering p...
Design and direct, as principal, important engineering work	Yes	Yes	Yes	
Practice of profession	10 yr.	10 yr.	10 yr.	
Responsible charge	5 yr.	3 yr.	5 yr.	
No. of references required	5	5	5	3
	Assoc. Mem.	Member	Assoc. Mem.	Associate
Age	27 yr.	27 yr.	25 yr.	All persons desirous ... joining acceptable to the Board of Directors
Design or have charge of work, under direction	No	Yes	No	
Practice of profession	6 yr.	5 yr.	6 yr.	
In charge of work	1 yr.	...	1 yr.	
No. of references	5	4	5	3
	Junior	Associate	Junior	
Age	21-29 yr.	21 yr.	18-31 yr.	No grade
Practice	2 yr.	...	2 yr.	
Graduation from engineering school equivalent to practice	2 yr.	1 yr.	2 yr.	
No. of references	3	3	5	
Total membership	6,573	7,609	7,871	5,224

Shore Paving at Seaside Resort

During the summers of 1914 and 1915 the Metropolitan Park Commission of Massachusetts has been constructing shore protection at Revere Beach, an amusement resort only a few miles north of Boston, where an existing timber bulkhead had not prevented severe erosion of the foreshore and battering of the bulkhead by winter storms.

NEWLY BUILT SHORE-PROTECTION WORKS AT REVERE BEACH, MASS.

The protective structure is in the form of steps, as shown in the accompanying illustration. It is built of 1:2:4 concrete reinforced with ½-in. square rods and has a granolithic finish. Besides providing the desired protection to the shore, it furnishes seats for bathers and spectators who go there in enormous numbers on hot summer days, and it does not interfere with easy access to the beach from the boulevard, as a wall would.

Proper Use of Rams for Farm Water-Supplies

By W. G. Kirchoffer*

Many attempts have been made in the past to use hydraulic rams with flowing wells and springs, to secure water under sufficient pressure to supply farm buildings. Some installations have been more or less successful, but others have been failures, owing to the use of rams not of proper size or type. In the following paragraphs are

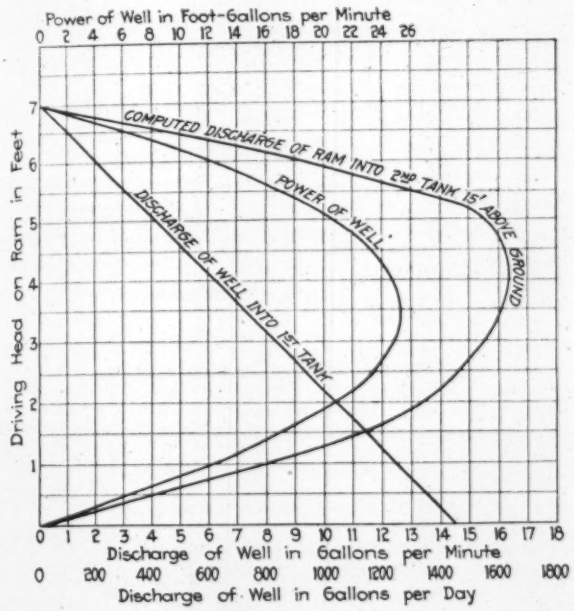
Power of Well in Foot-Gallons per Minute
0 2 4 6 8 10 12 14 16 18 20 22 24 26
COMPUTED DISCHARGE OF RAM INTO 2ND TANK 15' ABOVE GROUND
POWER OF WELL
DISCHARGE OF WELL INTO 1ST TANK
Driving Head on Ram in Feet
0 1 2 3 4 5 6 7
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Discharge of Well in Gallons per Minute
0 200 400 600 800 1000 1200 1400 1600 1800
Discharge of Well in Gallons per Day

FIG. 1. CHARACTERISTIC CURVES OF A FLOWING WELL

set forth the simple hydraulics necessary for successful treatment of such problems.

We often hear the remark that a certain well will flow a certain size of stream, or so many gallons per day, at a given height above ground, but no other information regarding the characteristics of the well is known. Properly to understand the workings or characteristics for a given well, one should know the maximum height to which water will rise in a confined pipe above ground, or above a given elevation, where a ram might be located. The flow of the well should also be measured at several points above the given elevation. From such data it is an easy matter to plot a diagram such as is shown in Fig. 1 and marked "Discharge of Well Into First Tank."

In this particular instance the discharge curve happens to be a straight line. The equation of flow of this well is $G = 14.50 - 2.07\ H$, in which H is head in feet and G is the gallons per minute. The natural inference would be to think that, if the ram was placed at the ground level, we would have a head of 5 ft. and a flow of about 10½ gal. per min.; but such is not the case. If the well is allowed to flow freely at any given level, the head above that point is all consumed in discharging the water through pipe. The only head avail-

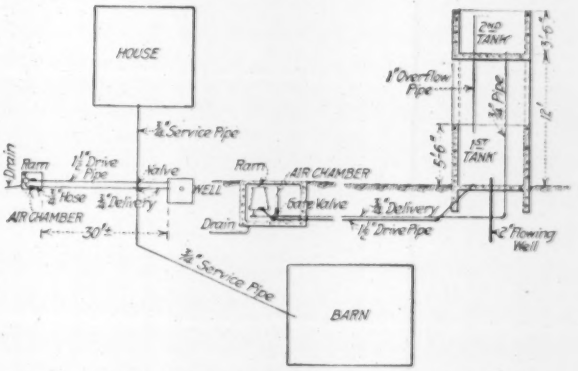

FIG. 2. PLAN AND ELEVATION OF A WISCONSIN FARM WATER-WORKS

able is the distance between this point of flow to the ground level, or to the bottom of the ditch—which in this case is 2 ft. below the ground level.

To arrive at the point where the power of the well is the greatest, so as to make the most efficient installation and secure the greatest discharge of the ram, it is only necessary to plot up the curve denoted as power of the well, which represents the product of feet of head and gallons per minute, or what is commonly called "foot-gallons per minute" (F). The equation of this curve is $F = 14.50\ H - 2.07\ H^2$. In this case H is the distance from the given elevation to the point of discharge.

The curve, as drawn, shows the power of the well for all points from 2 ft. below the ground to a point 5 ft. above ground, total head being 7 ft. The curve for this case shows that the greatest power of the well is obtained when the head is 3½ ft., or one-half the total head, and the discharge is 7½ gal. We should therefore select a ram that will work most efficiently when the head is 3½ ft. and the discharge is 7 gal. per min. The maximum power will be obtained at the middle point of the head on all wells whose discharge curve is a straight line.

Illustration of a Farm Supply

At the Wortham farm, near New London, Wis., there was a 2-in. artesian well 70 ft. deep. This well had the characteristics shown in Fig. 1. The total head of the well was determined by extending the well casing to a sufficient height so that the water would not flow over it, and the level of the water in the pipe was noted. Then the flow was measured in a 3-gal. pail at different elevations, which were noted. From these data the discharge line was plotted, and from this the power curve was derived. At this location the ground is level between the house and the barn, so that a head of 15 ft. above the ground surface was considered sufficient to supply the house and barn with the necessary water.

A concrete tank, about 6 ft. square by 5 ft. 6 in. high, was constructed over the well, and the well casing was cut off a few inches above the bottom. As the well was only a few feet from the house, it was decided to build a milkroom and cold-storage space about and over the

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tank. The upper tank, or the one into which the ram was to discharge, was located directly over the lower tank, so as to provide a cold-storage place between the two tanks and for the further reason that any surplus water pumped by the ram could overflow into the first tank and thereby help to keep up the driving head of the ram. By adjusting the operation of the ram so that it would take water from the lower tank at the rate of 7 gal. per min.—or what perhaps is easier, so that the head remains constant at 3½ ft.—a maximum amount of water will be pumped into the upper tank. The curve marked "Computed Discharge of Ram Into Second Tank," in Fig. 1, shows the amount of water in gallons per day that the ram will discharge at the different driving heads.

Objections to Rams Overcome

One objection to rams that has been made is that they are noisy, and if connected directly with a pipe leading into a house, the continual pounding becomes a nuisance. In the installation at the Wortham farm this objection was overcome by inserting between the ram and the discharge pipe a piece of rubber hose of diameter equal to that of the discharge pipe and by the use of an additional air chamber on the discharge pipe between the hose and the ram. The additional cushion furnished by the air chamber and the flexibility of the hose completely destroyed the propagation of the sound to the discharge tank. One could place an ear in contact with the discharge pipe as it passed through the milk house to the tank, and no sound could be detected.

Many rams will stop if the discharge head is suddenly increased, as it would be if pumping directly to a delivery pipe and the valve on it was partly closed suddenly. Also if the relief valve on some rams is purposely closed by hand, they will not automatically start again. However, the ram installed at the Wortham farm was adjusted so closely that it would start regardless of these conditions.

A plant similar to the one just described could be installed where the supply was from a spring, as well as from an artesian well. The same data should be collected and an analysis made of the problems, the same as for a well. High-efficiency rams will raise water where the ratio of driving head to discharge head is as great as 1 to 30, so that a head of 2 ft. with large discharge may often be of value.

Field for Automatic Pumps

Where the supply of water from the well or spring is relatively large as compared to the demand, an automatic pump could be used (double-ended reciprocating types like the Laursen machine). The particular advantage in the use of an automatic pump is that the elevated storage tank can be dispensed with and the discharge piped to the point of delivery. Whenever the faucet is opened, the pump starts to deliver water; and it automatically stops when the discharge is closed. These pumps can be used where the head and quantity of spring or well water might not be for house use or where there might be a head of water on a small stream sufficient to supply the power. These pumps can be operated safely where a polluted water is used for power, without danger of contaminating the pure water that is used for domestic purposes. They are also being used to supply water to railroads and factories from dams on small streams, where the purity of the water is not important.

Forms for Reporting Pavement History and Traffic

The forms shown herewith were presented at the last annual meeting of the Canadian Society of Civil Engineers by the Committee on Roads and Pavements.

HISTORY OF PAVEMENT

Municipality.....Kind of pavement.....Year laid.....
Engineer in charge.....Present address.....
Name of street or road.....From.....To.....
Total width or road allowance.....Bearing of street.....
Length of pavement.....Width.....Area in sq.yd.....
Cost per sq.yd., exclusive of subgrade, curb and gutter.....
Subgrade—Cost per sq.yd. of pavement.....
Subsoil.....crowned or flat.....watered or dry.....
What provision for drainage of subgrade.....
Were sewers, water mains, etc., laid before construction of pavement ..... and .....
When.....Location with respect to pavement.....
Foundation—Cost per sq.yd.....
Kind..... Materials..... Thickness..... Proportions.....
Binder Course or Cushion—Cost per sq.yd.....
Kind..... Materials..... Thickness..... Proportions.....
Surface Course—Cost per sq.yd.....
Kind..... Materials..... Thickness..... Proportions.....
Curb—Cost per lin.ft.....
Kind.... Width.... Depth.... Materials.... Proportions.....
Gutter—Cost per lin.ft.....
Kind... Width... Thickness... Materials.... Proportions.....
Details of catch basin.....
Grade of pavement, minimum.....maximum.....ordinary.....
Crown of pavement, minimum.....maximum.....
Character of street, business, industrial, etc.....
Average daily traffic in terms of traffic schedule before and after improvement .....
Summer temperature, maximum....minimum....average.....
Winter temperature, maximum....minimum....average.....
Annual rainfall, in.....Annual snowfall, in.....
Depth of frost line.....
Weather conditions during laying of pavement.....
Remarks .....
Dimensioned sketch of cross-section of pavement, photograph also desirable.....
Municipality.....Street or road.....From.....To.....
Kindly state below all details regarding the following:
- Form in which wear of pavement was shown from year to year since construction.
- Methods of repair.
- Methods of maintenance.
- Cost of maintenance per sq.yd. of pavement.
- Cost per sq.yd. of repairs.
- Average daily traffic.
- Any additional information that will be of value.

CAN. SOC. C.E. FORM OF TRAFFIC CENSUS

Kind of Traffic	7-8 a.m.	8-9 a.m.	9-10 a.m.	10-11 a.m.	11-12 a.m.	12-1 p.m.	1-2 p.m.	2-3 p.m.	3-4 p.m.	4-5 p.m.	5-6 p.m.	6-7 p.m.	Totals
One-horse light vehicles													
One-horse heavy vehicles													
Empty													
Loaded													
Two-horse light vehicles													
Empty													
Loaded													
Two-horse heavy vehicles													
Empty													
Loaded													
Run-abouts													
Light touring cars													
Empty													
Loaded													
Heavy touring cars													
Empty													
Loaded													
Light motor trucks													
Empty													
Loaded													
Heavy motor trucks													
Empty													
Loaded													
Weather													

Monolithic Concrete Curb and Pavement in Arcade, N. Y.

By E. J. Doyle*

SYNOPSIS—Pavement has two courses. Concrete placed in 25-ft. sections separated by expansion joints. Details of curb forms. Amount of water used in concrete different in dry than in wet weather. Work proceeded at rate of six sections, or 70 to 90 cu.yd. per day. Costs.

A concrete pavement was constructed for the village of Arcade, N. Y., in 1915 that has attracted considerable attention because of some unusual features of construction that were employed. The distinctive features were the construction of curbs and pavement in monolithic units, reinforcing each unit with bars to prevent temperature cracks and using a top course of concrete containing traprock instead of gravel, as in the lower course.

Constructing the curb and pavement as a unit reduced the formwork of curbs to a minimum, centralized all concreting and shortened the period of construction. Under the ordinary method a full organization must be employed, and the work is a duplication of the force and operations required in laying down the pavement.

The cross-section chosen is shown in Fig. 1. It called for two courses of concrete, the bottom course being gravel concrete and the top of stone. As local gravel of good quality could be obtained at low cost, its use effected a considerable saving.

Description of the Pavement

The street had a 22-ft. roadway, with tree lawns on each side. The maximum grade was 1.8%, the minimum, 0.34%. The bottom course was a 1 : 3 : 6 (screened gravel) mix. Stone was used in the top course and was graded from chips to 1-in. pieces. It was tested for voids, which were found to be between 22 and 28% of the bulk. Tests of a 1 : 1½ : 3 mix indicated that the mortar was too unstable when sufficient water had been added to bring it to the desired degree of fluidity. Accordingly a 1 : 1 : 3 mix was used for the top-course concrete.

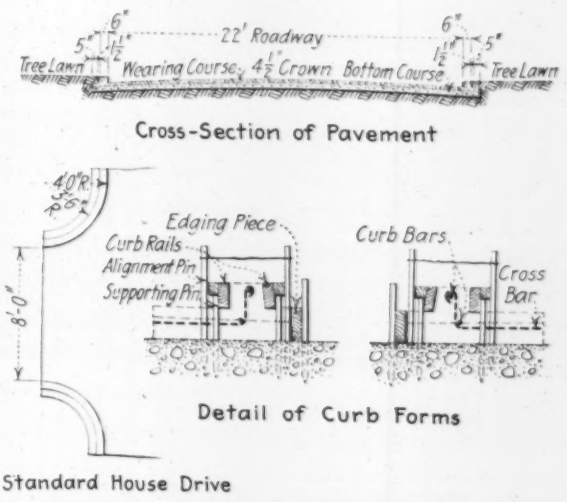

FIG. 1. DESIGN AND CONSTRUCTION DETAILS OF THE ARCADE (N. Y.) CONCRETE PAVEMENT

The bottom course was 4 in. thick at the sides and 5 in. at the center. The top course had a uniform thickness of 2 in. The concrete was placed in 25-ft. sections, the sections being separated by a ⅜-in. prepared

FIG. 2. CONSTRUCTING CURB AND PAVEMENT IN MONOLITHIC UNITS

*Consulting Engineer, 83 State St., Albany, N. Y.

asphaltic expansion strip. The curbs, which rose 4½ in. above the pavement, were reinforced with two ½-in. bars. The pavement was reinforced with crossbars of the same size, spaced 4 ft. c. to c. The crossbars were looped at each end and bent up in an L-shape in the curbs. One curb bar was passed through the loop, and the other was placed on the inside of the L, to give the crossbar an anchorage.

The curbs had no expansion joints except those at the end of a section, which were the same as the roadway joints. The roadway was crowned 4½ in., and a hyperbolic profile was adopted to allow for sloughing of the fresh concrete from the center and the consequent rising of the quarter-points. Cross-sections of the hardened pavement showed that the sloughing was of such extent that the profile of the final cross-section conformed very nearly to the arc of a circle.

A plank bulkhead that conformed to the surface of the subgrade and finished pavement was secured in place with pins. A trussed templet, used in forming the cross-contour of the top and bottom courses of concrete, was made of light pine boards, so that its weight would not depress the curb rails and deform the contour of its templet edge. The contour of the bottom course of concrete was obtained by floating under the templet with a float that had a spacing block attached to the top of its blade. The street-intersection and house-drive

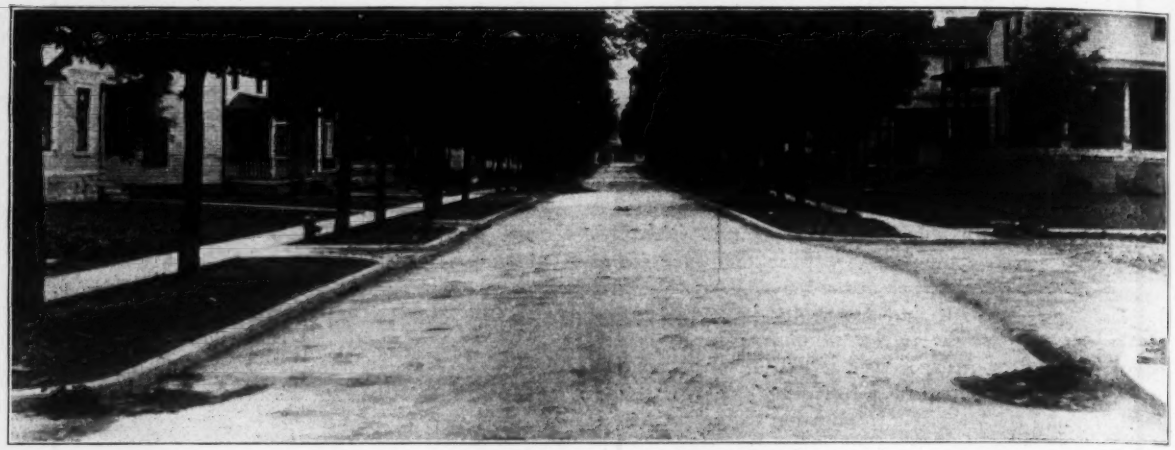

FIG. 3. THE COMPLETED TWO-COURSE PAVEMENT ON PARK ST., ARCADE, N. Y.

The Curb Forms and How They Were Placed

The curb forms consisted of two curb rails and an edging plank. The rails were supported on iron pins, which held them 6 in. above the subgrade and on the plane of the pavement surface. The edging plank was set on the subgrade, outside the rails, to form a 5-in. heel. The rails were made up of 6-in. planks sawed to 4½ in., with a 1½-in. piece spiked to the outside of the rail, at the top, to give the rail an inverted L-shape. The rails were fitted with dowels at the ends, to hold them in alignment without nailing. The supporting pins were spaced about 4 ft. c. to c., and the forms were held in alignment by pins driven along their sides at short intervals and wired across. The supporting pins were of round iron, to facilitate their removal.

In setting the curb forms batten boards were set on stakes opposite the grade and alignment stakes, a line was drawn, the supporting pins were put in position and driven to about ½ in. above their final grade, and the rails were placed with the long arm of the L in a vertical position inside the pins and the outstanding short arm resting on the pins. Alignment pins were then driven and wired. No effort was made to set the edging plank on an exact grade, as the heel of the curb was covered when completed.

Before concreting a section, the curb rails were brought to true grade by tamping them over their pin supports. radii were each in a built-up unit and were set and secured in the same manner as the straight forms. Bulkheads for the house drives were made with a 1-in. crown.

The concrete was mixed by a ½-yd. Koehring mixer with bucket loader and crane delivery. The sand and gravel were screened by a portable rotary screen driven by a gasoline motor. The screen had a capacity of 90 cu.yd. in a 10 hr. working day. The gravel was conveyed from bed to screen by two teams on drag scrapers, and the screen was moved along as the bed was worked.

Only two men were required to set and reset the curb forms. The concreting gang was made up of a foreman; a fireman; an engineer; a bucket-hoist man; a crane operator; two men on the cement; seven on sand, gravel and stone; three manipulating concrete on the grade and filling curb forms; one on the first float over; one pavement finisher, and one curb finisher. One team and an extra man were required to haul cement to the mixer.

The subgrade was rolled after a light shower or, in dry weather, after sprinkling. This procedure resulted in a hard surface that was damaged but little by hauling supplies over it. All materials except the cement were delivered a considerable distance ahead of the mixer. The cement was delivered as required and in most part was taken directly from the cars. The sand, gravel and crushed stone were dumped in rows on the subgrade, each class of material being piled in a separate row.

Each batch of concrete was mixed about 50 sec. The bottom-course concrete was mixed with sufficient water to make it flow sluggishly while being manipulated on the subgrade—a consistency that made it possible to do most of the spreading with floats and long-handled hoes. The top-course concrete was made plastic. No fixed

quantity of water was used in either the top or the bottom course, as the quantity that was required varied greatly in dry and showery weather.

Before concreting a section, the form-setter graded up the curb forms, and the curb finisher placed the reinforcing bars. The bulkhead was placed and lined up with an expansion strip. The bottom course of concrete was laid down to the half-point of the section and floated off. It was followed with the top course to the third point. The other half-section of the bottom course was then laid down and the section completed with the top course. This procedure was followed so that the workmen could manipulate the courses without standing in the concrete that had been floated off. The floating was done with steel floats that had been fitted with long bamboo handles.

After a half-section of the bottom course had been laid down and floated off ready to receive the top course, part of its water had run off. This hardened the concrete to such an extent that it did not intermix with the top course, except that the mortar coat which had been floated to the surface embedded the stone of the top-course concrete. The top of the curb was filled with top-course concrete, which was shoveled into the forms as it was dumped from the bucket. The curbs were given no mortar coat, and a natural mortar finish was obtained by troweling them out while the concrete was fresh.

The top course was floated over three times, the final floating being done as soon as the final set had started. In warm weather the fresh concrete was sprinkled frequently, and in showery weather it was covered with tar paper laid crosswise. The curb forms were removed the morning after the concrete had been placed. One man removed the forms of a day's run and cleaned and carried them ahead for resetting, in about 2 hr. The finisher drew the pins and grouted up the holes they left, as soon as the forms had been removed.

The fresh concrete was not covered with sand, but was sprinkled at frequent intervals for several days during dry warm weather. The pavement was opened to traffic in 12 to 14 days after placing. A normal day's run was five to six sections, which with house drives and curbs required from 70 to 90 cu.yd. of concrete. The regular working day was 10 hr. No section was started that could not be completed in a continuous run; and if a section was completed an hour before quitting time, as was often the case, the men were put to work grading tree lawns back of the mixer.

A record of costs indicated that the pavement, including excavation and grading, was constructed for about 80c. per sq.yd. and that the curbs, including radius curbs, cost 21c. per lin.ft. The items making up the cost of curb were: Forms, 3c.; setting forms 3c.; concrete, 10c.; reinforcement, 3c. and finishing, 2c.

Plans and specifications were prepared by, and the work was performed under the general supervision of, the writer, who was consulting engineer for Arcade. R. T. Spiegel was in immediate charge. The contractor was Frank M. Foote. The photographs were supplied by F. M. Traynor, of the Lehigh Portland Cement Co., and by the contractor.

January Rainfall in Mountains Near Los Angeles*

At the instigation of members of the American Society of Civil Engineers there have been established in southern California by the United States Weather Bureau 11 rainfall stations, located at various elevations in the mountainous regions. These stations were established with standard equipment by Dr. Ford Carpenter, local observer. During the heavy rains of January, 1916, some of these stations were destroyed, so only the data herewith are available.

INCHES OF DAILY RAINFALL IN JANUARY, 1916, AT MOUNTAIN STATIONS IN LOS ANGELES COUNTY, CALIFORNIA

Station*	Elevation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Clearwater power station	2,350	....	1.55	0.03	0.08	....	0.02	....	....	0.98	0.60	....	....	....	....	0.61	....
Camp Bonita	2,000	....	1.78	0.24	0.18	0.36	0.17	....	....	1.20	0.81	1.00	....	....	....	0.88	0.05
Iron Forks, San Gabriel River	3,500	1.50	0.50	0.45	0.31	....	....	....	1.43	....	1.80	....	....	....	....	1.12	....
Littlelands	1,800	0.01	1.20	0.80	0.15	0.30	0.10	....	....	0.75	0.35	0.56	....	....	0.05	0.80	0.01
		2.0†	trace†			trace†	0.10†			4.0†					2.0†		0.5†
Mt. Wilson	5,850	0.27	1.47	0.03	0.57	0.42	0.18	....	1.23	1.00	....	....	....	....	0.62	0.31	0.58
Neenach (Antelope) siphon	3,000	5.0†	0.25	0.20	0.12	....	....	....	....	0.04	0.07	0.7†	....	....	....	0.25	
Pacoima	1,570	....	0.60	0.40	0.26	0.55	0.09	....	....	0.96	0.45	0.15	....	....	....	0.20	

Station	Elevation	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	T. a
Clearwater power station	2,350	....	4.40	0.30	....	....	....	....	0.17	0.25	....	1.85	....	0.50	....	....	
Camp Bonita	2,000	5.18	8.90	1.60	0.20	....	....	....	....	0.76	0.05	1.54	3.32	....	0.52	....	28.71
Iron Forks, San Gabriel River	3,500	....	———	16.75	———	....	....	....	....	———	4.55	———	....	0.60	....	....	
Littlelands	1,800	4.08	3.38	0.50	0.15	....	trace	....	0.08	0.60	0.04	1.22	0.91	0.51	....	....	21.04
			1.5†	8.0†								6.0†	0.5†	5.0†			
Mt. Wilson	5,850	6.38	4.37	0.18	0.96	....	....	0.02	0.36	0.76	0.03	4.4	0.03	0.30	....	....	
Neenach (Antelope) siphon	3,000	1.40	0.90	0.25	....	....	....	0.04	....	....	....	0.12	....	....	0.09	....	3.70
Pacoima	1,570	4.50	3.05	0.57	0.15	....	....	0.10	....	0.75	0.05	1.36	1.09	....	0.40	....	

* All the stations are in Los Angeles County. † Snow.

At Los Angeles the total precipitation for January, 1916, was 13.3 in., as compared with a normal of 4.16 in. From Sept. 1 to Jan. 31 the total rainfall at Los Angeles was 17.17 in., contrasted with 8.05 in. normal. High daily rainfalls at Los Angeles during January since 1877 have been 7.83 in 1890, 7.72 in 1886, 6.03 in 1888 and 5.84 in 1895.

Development of the Foreign Trade of the United States is urged by the National Chamber of Commerce. A referendum vote has just been taken of commercial organizations throughout the country; 307 different organizations located in 42 states took part in the ballot. The vote was on the approval of the report of a committee that advocated increased appropriations and a strengthening of the staff of the United States consular service and the Bureau of Foreign and Domestic Commerce. Five new commercial attachés were recommended, special attention was given to the development of commerce in Latin America, and it was urged that the consular service be Americanized. On the detailed propositions in the ballot the vote was generally 850 to 875 in favor, with only from 8 to 40 in opposition. In this connection it is of interest to note that Dr. E. E. Pratt in his annual report declares that the chief difficulty in the development of foreign trade is the lack of competent educated men to conduct it. He states that his bureau finds it difficult to obtain men of education and good address who are good linguists and have a fair knowledge of commercial geography.

*From Roy A. Silent, Engineering offices of J. B. Lippincott, Central Building, Los Angeles, Calif.

Design of Rock-Fill Dams

SYNOPSIS—An account of the failure of the Lower Otay dam, near San Diego, Calif., on Jan. 27, with editorial comment thereon, published in "Engineering News" of Feb. 3 and 10, has brought forth discussion by four engineers of the principal features in the design of such dams. It is contended that they should be given a more ample cross-section than has generally been adopted and should not be expected to withstand overflow. Comment on this discussion is made in the editorial columns of this issue.

Rock-Fill Dams Tested by the Record of Experience

By Francis L. Sellew*

Engineering News of Feb. 3 contains an account of the destruction of the Lower Otay dam, near San Diego, also a description of the work, with some comment upon its design and construction, which leaves the impression that the sole cause of the disaster was structural weakness. The structure was weak, and your criticism is fully justified. Still, a familiarity with local conditions leads one to suggest that, had the managers of the works manifested a decent regard for its infirmities, the dam could have been saved and a needless accident avoided. No detailed analysis of the dam will be attempted here, and none is necessary, for a superficial examination will show its weakness with a full reservoir—a condition which should never have been allowed to occur.

Assume the cross-section which you publish, having a top width of 16 ft., side slopes of 1½ : 1, height 130 ft., with steel diaphragm located on the line of the top of the water slope, allowing free access of the water pressure to that plane, leaving the rock-fill below the diaphragm the sole dependence for stability, as you suggest. With the water-level even with the top of the dam the normal water pressure on 1 lin.ft. was $62.5 \times 130 \times 65 = 528{,}000$ lb., or 264 tons. Opposed to this would be a rock-fill of 14,750 cu.ft., or 550 cu.yd. In the absence of specific information let us assume that the rock weighed, solid, 150 lb. per cu.ft., or 4,050 lb. per yd., and when broken, contained 40% voids, giving, say, 2,500 lb. as the weight of a cubic yard in place. Then the opposing force would be $550 \times 1\frac{1}{4} = 690$ tons and the coefficient against sliding, 690 divided by 264, which is 2.6.

COEFFICIENT AGAINST SLIDING

Location of Dam	With Reservoir Full	With Reservoir 5 Ft. Below Top	Remarks
Lower Otay, slopes 1½ : 1	2.6	2.85	As designed
Lower Otay, slopes 1 : 1	1.85	2.04	As built, 1897; failed, 1916
Escondido, Calif.	3.25	3.50	Built, 1895
Castlewood, Colo.	2.1	...	Built, 1890; rock-fill with masonry faces
East Cañon Creek, Utah	4.0	...	Built, 1899; 68 ft. high; enlarged, 1900, to 93 ft.
Pecos River, New Mexico	3.35	...	Built, 1890; failed, 1893; rebuilt, failed, 1894; rebuilt
Walnut Grove, Ariz.	2.60	...	Built, 1887; failed, 1890

The spillway floor was at El. 124, or about 6 ft. below the crest of the dam; and had the water been held at that level, the normal pressure would have been 240 tons with the same opposing force, giving a coefficient of about 2.9. However, as you point out, the structure probably was not built to the design, and the slopes were more nearly 1 : 1.

Under such conditions with a full reservoir the normal pressure would be, as before, 264 tons; but the opposing force would reduce to 390 cu.yd., or 490 tons, and the coefficient against sliding to $\frac{490}{264}$, or 1.85. Had the water been held at spillway level, the coefficient would have been $\frac{490}{240}$, or 2.04.

This analysis brings up the question of a safe coefficient against sliding for a rock-fill dam. In masonry-dam design a common value for this coefficient is 2, and for earth dams the best practice gives 10. It is apparent that the safe figure for a rock-fill will lie between these two; and as a guide for determining its proper value the accompanying table has been prepared from an examination of several structures, of which some have failed and others are still standing.

The Escondido dam, located a short distance from San Diego, has a maximum height of 76 ft.; a top width of 10 ft.; water slope, ½ : 1; downstream slope, 1 : 1 for the top half and 1¼ below; total bottom width, 140 ft. In the calculations the vertical component of the water pressure was added to the weight of the fill to make up the resisting force. The upstream slope of the dam has a plank face, which is assumed to be impervious. The entire weight of the fill is therefore available to resist the water pressure. This dam has withstood successfully all floods since 1895.

The Castlewood dam, Colorado, was built in 1890, the rockfill having a top width of 8 ft.; water slope, 1 : 10; downstream slope, 1 : 1; total bottom width, 85 ft. The water face is of rubble masonry 4 ft. thick, and the lower slope is built in 2-ft. steps with large stones in cement mortar. There was considerable leakage, and an earth-fill was added on the upper side with 8 ft. top width and 3 : 1 slope. This addition was merely to reduce leakage, and in determining the coefficient against sliding the rock-fill was considered the sole support. No allowance was made for the rock-fill acting as a retaining wall for a part of the earth-fill.

The East Cañon Creek rock-fill dam, Utah, was originally built 68 ft. high in 1899. It was enlarged in 1900, its principal dimensions being: Height, 93 ft.; crest width, 10 ft.; water face, vertical and covered with boiler plate; downstream slope, 2 : 1. The bottom width is about 250 ft. Boiler plate is connected to a concrete cutoff, which extends to bedrock. In the calculations the upstream face was assumed impervious and the water pressure resisted by the entire rock-fill.

The Pecos River dam was built in 1889-90 near Eddy, N. M. Its height is 48 ft.; crest, 10 ft.; water face, ½ : 1; downstream face, 1½ : 1; bottom width, 106

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ft. The foregoing figures are the dimensions of the rock-fill; but to insure water-tightness, an earth embankment was added on the upper side, the top width being 10 ft. and the slope 3:1. The amount of earth so placed was 100,000 cu.yd. In figuring the factor of safety the opposing force has been considered as the rock-fill plus the vertical component of the water pressure on the inclined upstream face. This dam was overtopped by a flood in 1893 and washed out. It was immediately rebuilt with additional spillway capacity and the rock-fill given 5 ft. additional elevation. Referring to this dam, Wegmann says: "The type of rock-fill dam described above appears to be perfectly safe if an ample wasteway is provided."

However, the dam was again destroyed in 1894, the water this time forcing its way through, but not passing over, the top. Its failure was stated to be due to burrowing animals or faulty construction where the dam connected with the bank. The dam was again rebuilt with increase in the earth-fill and the addition of a concrete core wall. The calculations previously given for safety against sliding relate to the original cross-section.

The Walnut Grove dam, in Northern Arizona, was built in 1887 and failed in 1890. The structure had a top width of 10 ft.; maximum height, 110 ft.; water slope, 1 horizontal to 2.3 vertical; downstream slope, 1 horizontal to 1.55 vertical for the top half, the lower portion being increased, the dam having a bottom width of about 175 ft. Probably the steepness of the downstream slope had much to do with the failure of this structure, although its sliding coefficient is less than it should be.

An examination of the table shows that the Walnut Grove dam had a coefficient against sliding, with full reservoir, of 2.6, or about 50% greater than Lower Otay, while the Pecos River rock-fill, which went out in 1893 and again in 1894, had a coefficient 80% greater. If allowance is made for retaining-wall action at Lower Otay and the weakening of the section on account of saturation from leakage, the discrepancy between the coefficients is still greater; but comparing the values as given in the table, these two failures—one occurring seven years and the other four years before the Lower Otay was built—should have caused the designers of the latter structure to "Stop, look and listen."

Eliminating the Castlewood dam, which by reason of its masonry faces is rather a modified rock-fill, the table shows that the successful rock-fill dams had in the case of Escondido a coefficient of 3.25 and at East Cañon Creek, 4. The Escondido dam was built subsequent to the failure at Pecos River and at Walnut Grove, but prior to the construction of the Lower Otay. It would have been a fair guide to follow, but probably was so near that it was overlooked.

It appears from the data herewith submitted, after making allowance for all factors, certain and uncertain, that a rock-fill dam should have a coefficient against sliding of at least 3½, and 4 would be better. If this assumption is correct, then the maximum height to which the Lower Otay reservoir should have been filled was 93 ft. and not over 130, as it was at the time of failure; even at spillway level, 6 ft. below the top of the structure, the factor was 2.04.

The facts here presented are matters of record, readily obtainable. It is therefore pertinent to ask why the reservoir was allowed to fill, when such a condition was almost certain to cause disaster. The structure was so weak under maximum conditions that the filling of the reservoir was as great an error as the design of the dam.

Action of Water on Rock Fills

By Ralph Bennett*

Referring to your recent editorial on the stability of rock-fill dams, you appear to assume that the downstream face of a rock-fill dam, properly surfaced with stone blocks, can be used as a spillway for extensive flood flows. I do not believe that either the correct theory or the successful practice with structures of this character will permit of any flow whatever being discharged over the back of such a structure.

The stability of any dam, properly founded, is dependent on its resistance as a mass to overturning or on its stability as a framed structure, but in either case the materials must be protected against progressive destruction, disintegration or removal.

A rock-fill dam cannot be considered to have any features of a structural nature. Even when carefully derrick-placed on the upstream slope, the downstream face is random dumping. Such a rock pile contains many crevices and is likely to be composed to a considerable extent of angular fragments resting on corners so small that the material is very highly loaded at the points of contact. Depending on the shape of the fragments and the manner of placing, the slopes will be internally stable at a slope that may be averaged at 1 on 1. With this slope, superimposed vertical load will cause more or less extensive slips until the slopes have adjusted themselves to the new conditions. A rock pile with a materially flatter face, say 1 vertical on 1½ horizontal, is reasonably free from such slips. This flatter slope is quite generally assumed as amply safe for rock-fill dams, and occasionally much steeper faces are used with favorable rock and some hand placing; but the enormous masses required on flat slopes require that the steepest safe face be used.

When loaded at an angle perpendicular to the water face with a water load, as in the case of full reservoir, the internal stresses in the rock-fill dam may be supposed to travel along lines that are the resultant of the water pressure and the dead weight of the dam, as in the case of a masonry dam. But the distribution of the stress will be much less even in the loose rock than it will be in a concrete mass. The semifluidity of the pile will transfer portions of the loading to the sides of the pressure lines and so toward the unrestrained outer face. A condition may then arise under which a bulging and failure of the outer or downstream face of a rock-fill may occur, owing to pressure from the upstream face. This condition is analogous to the transfer of pressures in a grain bin. There appear to be few or no experiments on this most interesting and important matter.

Under the conditions most frequently met with there is a considerable amount of earth, sand and spall embodied in the rock-fills. As this material may be more slippery than the rock of the body of the fill, it may increase the chance of failures due to internal stresses. This result will particularly be the case if the mass is wet.

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It may safely be said that a rock-fill dam designed to suit the materials employed and sustaining a full reservoir will have a certain amount of load on every particle of its material and that minor slips and subsidences may be expected, if the structure is too light, well before full reservoir is reached.

Now, if water in considerable quantities is allowed to flow over the crest and down the lower face, several additional hazards are at once in evidence: There is considerable shock and vibration; the surface rock, even if massive and laid in courses, is called on to resist a very strong loosening and tearing action due to the mass and high velocity of the water; the fill, being less porous on the surface than in the body, will fill with water entering the crevices at all heights and be prevented from venting freely by the surface water; this entrained water will soften and lubricate the sand and dust present and will wash them away by slow attrition, even if loaded.

This water will also to a greater or less extent submerge the rock of the fill, which is held in place by its weight, and by reducing its effective weight reduce the total resistance of the dam. If already well loaded, the failure due to slips and slides from these causes may occur before that due to surface erosion.

When the rock-fill dam has had added to it all the crest width, paving and drains that would be essential to enable it to handle even a thin stream over its crest, its cost will so far exceed that of a single or multiple-arch dam for the same service that the only argument for its use—cheapness—will vanish.

If the conditions render the use of a long shallow spillway difficult or undesirable, it is possible to install siphon spillways, which will immensely increase the discharge per foot of crest and which will operate with great certainty on a head as low as 4 in. Some types of automatic flashboards are also available, which can be relied on. But in any case an ample length of free spillway crest is the safest insurance against overtopping failure in earth- and rock-fill dams.

Stresses in Arch Dams

By L. Jorgensen*

It may be that the Lower Otay dam was not held in such high repute by the engineering profession, but its failure was evidently due to washing out of the structure by the water overtopping its crest; and no matter how liberally the section had been proportioned, the result would probably have been the same. The only real protection would have been a larger spillway or a concrete structure. The lining of the crest and downstream face would undoubtedly be more expensive than a larger spillway and would not offer the same protection. In the writer's opinion well-constructed rock-fill dams are perfectly safe structures, if provided with sufficient spillway capacity; but for efficiency of material the water-tight cutoff should always be on the upstream face and not in the shape of a core wall.

When the first reports of the dam failure came out in the newspapers, its was not stated whether it was the lower or the upper dam that had failed. The writer, knowing that the upper dam was an arch dam and being especially interested in arch dams, started to figure out how the upper dam could have failed. He knew it was the highest-stressed arch dam in existence. As can be seen from the drawing and photographs on p. 288, *Engineering News*, Feb. 10, 1916, the arch is very flat. If this dam had failed, it would hardly have been fair to regard it as an arch-dam failure, although if it were not for its arch action, this dam would not now be standing. So far as the writer is aware, no arch dam has ever failed.

The stresses in the Upper Otay dam are difficult to ascertain. At lower elevations the dam has practically no curvature, and the load therefore must, to a great extent, be carried on the horizontal (curved) beams and through shear action to the rock sides and bottom. In the middle portion there will be some arch action, some horizontal curved-beam action, and some of the load will undoubtedly be transferred to both upper and lower elevations through vertical-beam action. The upper portion of the dam will then carry more than its corresponding water load on the arch. The upper portion of the arch is constructed with a rich mixture of concrete, which adds greatly to the safety of this structure. The reinforcement is present in such small quantities that it is negligible. Any structure that has withstood such a test without showing any signs of weakness is likely to have its "ultimate fate long delayed," as you say.

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Why Rock-Fill Dams Are Not Adapted To Resist Overflow

By Horace W. King*

In the editorial in *Engineering News* of Feb. 10, entitled "Is the Rock-Fill Dam a Safe Type of Dam?" three fundamental defects in the design of the Lower Otay dam are stated—namely, too small a cross-section, failure to pave the downstream slope and lack of a substantial crest to the dam. Without these defects, it is maintained, the dam would have withstood the flood of water that passed over it.

The writer is rather surprised at the position taken in this editorial, as he had not supposed that the rock-fill dam was ever considered as of the overflow type. In this respect it stands almost identically in the same class with the earth-fill dam. The rock-fill dam has an advantage over the earth dam in that failure is not so likely to result from seepage starting along the outlet works or at the junction with the banks of the stream, but it has no advantage in the regard mentioned. The writer cannot conceive of rocks weighing from one-half ton to three tons being so well laid that the terrific force of a large volume of water passing down the lower face of the dam will not dislodge them. The writer would like to inquire whether an overflow rock-fill dam is anywhere in existence.

In the case of the Lower Otay dam it appears that the structure withstood the pressure of the water safely until it was overtopped. In this respect it did all that any dam of this type could be expected to do. The real cause of the failure was insufficient spillway capacity. A separate spillway of capacity sufficient to discharge the maximum flood with the water surface in the reservoir at least 10 ft. below the crest of the dam is not too great a margin of safety.

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Rock-fill dams are particularly suited to certain localities in the western United States, on streams flowing through rock cañons where suitable material for an earth dam is scarce and materials for masonry dams are prohibitive in cost. In such cases a rock-fill dam may provide the most economical and satisfactory solution of the problem. A spillway, detached from the structure, must always be provided for dams of this type. The spillway may, if topographic features are suitable, be located in a saddle remote from the dam, or it may be necessary to construct it in the sides of the cañon just above the dam. In the latter case the material excavated from the spillway may be deposited in the dam.

A substantial cutoff extending from an impervious foundation to the elevation of the maximum water surface is essential in a dam of this type, but rock of an indifferent character may be used in the body of the dam. Rock may be used for this purpose that would not be satisfactory for a masonry structure, which fact may lead to the choice of a rock-fill dam rather than a masonry dam for a particular locality.

In the writer's opinion a rock-fill dam, if properly designed, may be a perfectly satisfactory structure, but it will be safe only in case sufficient spillway capacity is provided to prevent water from passing over its crest. The three or four failures of rock-fill dams that have been recorded all appear to be traceable to one cause—failure to provide adequate spillway capacity.

Work of the Dallas Department of Public Health

EDITORIAL CORRESPONDENCE

Dallas, Tex., has a bureau of sanitation directly supervised by engineers. The city department of health was created by the city commission on May 5, 1915. It is theoretically under the general supervision of an advisory board of health (unpaid) of 13 members, appointed by the mayor, who is chairman. The law requires that 6 of the 13 members shall be practicing physicians. The board is composed of prominent physicians whose connection with it gives it considerable popular prestige.

The work of the department is divided into three bureaus or divisions—sanitation, care of the sick, hospital work—each in charge (theoretically) of a committee of the board of health. The bureau of sanitation is in charge of Charles Saville, a graduate in sanitary engineering of the Massachusetts Institute of Technology and formerly with Hering & Gregory, consulting engineers, New York City. The assistant chief of the bureau of sanitation, Henry W. Van Hovenberg, is also a graduate in sanitary engineering of the Massachusetts Institute of Technology. The heads of the other two bureaus are physicians.

Under the director of sanitation are two divisions—one of sanitation and public-health instruction and one of food and milk inspection and analysis. The division of vital statistics is under the health officer, who heads the bureau of caring for the sick. The collection and disposal of garbage and refuse and the cleaning of the streets are not a part of the work of the department of health, but are in charge of superintendents who report to the commissioner of streets and public property. However, the bureau of sanitation coöperates with these departments as well as with the water and sewer departments, and the director of sanitation is now engaged in a special study and investigation of garbage disposal.

The principal work of the bureau of sanitation is the inspection of food and milk supplies and the inspection and abolition of nuisances. Systematic inspections are made of all dairies and of all places where food is offered for sale. The condition of these places is rated on score cards that take into consideration the sanitary conditions of the building and equipment, the character and condition of the foodstuffs, the health and cleanliness of employees, toilet and washing facilities. These items are rated according to their relative importance, so as to make 100 a perfect score. The scores are furnished to housewives and others on request and are a stimulant to general cleanliness on the part of all who handle foodstuffs. Inspectors of the bureau of sanitation also condemn and destroy all foodstuffs unfit for human consumption.

SANITARY INSPECTION – CITY OF DALLAS – HEALTH DEPARTMENT

Street ..... No. ..... Date .....

Owner / Agent ..... Occupant ..... White / Colored / Mexican

Number of occupants, total ..... Children under 5 years .....

WATER SUPPLY

City Supply—*Yes, No.* In House—*Yes, No.* On Premises—*Yes, No.*

Other Supply—*Yes, No.* Describe .....

Possible Pollution of Supply—*Yes, No* .....

SEWAGE

Sewer Connection—*Yes, No.* In House.—*Yes, No.* Condition—*Good, Bad*

Dry Closet—*Yes, No.* Used by Family—*Yes, No.* Used by Servant—*Yes No* Condition—*Good, Bad*

GENERAL

Milk supplied by Dairy—Occupant—Neighbor—Store

Roomers, Boarders—*Yes. No.*

Condition of Premises—*Good, Bad*

Inspector .....

Animals	No.
Dogs	
Cows	
Horses	
Mules	
Hogs	
Chickens	
Cats	

SANITARY-INSPECTION RECORD CARD, DALLAS, TEX.
The original is 6x4 in.

The inspection of premises, the elimination of dry closets within the sewered area and the enforcement of the sanitary code form a large part of the work of the inspectors of the bureau of sanitation. A sanitary-inspection card used by Mr. Saville is reproduced herewith. Another phase of the work is the examination and abolition of all places that breed malaria-bearing mosquitoes. Then, of course, there is the usual routine work of handling miscellaneous complaints. A system has been worked out for attending to these complaints as expeditiously as possible by the use of special forms that are referred directly to police, legal or welfare departments for action.

With the coöperation of two or three of the local newspapers it has been possible to give considerable publicity to the work the bureau of sanitation is attempting to accomplish. The efforts of the bureau have also been much assisted by a local society for municipal research, which has a committee on sanitation and housing. This society is composed of department heads and other employees of the municipal government of Dallas, and its aim is "to study and initiate progressive, efficient and economical methods in municipal business affairs and to bring about a closer coöperation of the various departments of the city government." Altogether, the work accomplished in the first year of its existence by the new Dallas department of public health is a fine example of what technically trained sanitary engineers may accomplish in public-health work.

Field and Office

Methods Used in Comprehensive Survey of Buffalo, N. Y.

Until 1903 there were no accurate survey records of the City of Buffalo, N. Y., for use of the assessors—a condition of affairs common to a great many American cities. Such maps as existed were compilations of lot and subdivision surveys, and were as full of inconsistencies as such compilations always are. In 1903 a City Survey Division of the Bureau of Engineering was established, and ever since then a thorough and systematic survey of the city has been under way.

It was intended to base this survey on a triangulation net established by precise methods, but owing to the necessary slowness of this work and the great demands made for special surveys the triangulation has been only partly completed. In order to go ahead with the detail survey without the governing triangulation the surveys are based on closed traverses, about ½ or ¾ mi. square, run through the principal streets. The limiting error of closure for these traverses is 1 in 10,000.

Ordinary methods for city survey work were employed, except that linear measurements were made with a 100-ft. invar tape laid on the ground. Three tapemen were required, one to carry the tape in the middle, for it must at no time be allowed to drag on the ground because of its liability to breakage and injury. Marks cut in sidewalks were used as stations. One monument was set at each street corner—a plain stone shaft, to be ultimately replaced with the type of monument shown in Fig. 1. These future monuments are to be set at street-line intersections, on range with one of the street lines and on an offset of 2 ft. from the other, at intervals of 1,000 ft. The intermediate street lines are to be marked with plain stone monuments set flush with the surface of the ground.

To keep record of the progress of the work, a wall map of the whole city is used, upon which is noted within

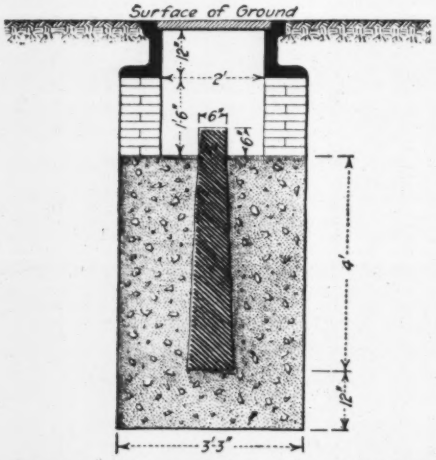


FIG. 1. TYPE OF CITY SURVEY MONUMENT TO BE USED IN BUFFALO, N. Y.

the lines of each street the number of the field-book and page-number which contains the survey notes of that particular part of the street; also the number of the rolled map upon which the survey notes are plotted in detail.

The original record map is drawn on cloth-backed paper on a scale of 200 ft. to the inch, forming rolls 42 in. wide by 20 ft. long (north and south). Street and property lines with original record and deed distances are shown in black; measured distances and courses are in blue (or green originally) and adjusted distances and courses in red. This map shows the frontage of every lot on the street (in many instances the depths of lots are also shown because it was necessary to fix the back corners of the lot to establish the frontage), and also one front corner of any building on the lot.

The city is divided into 14 tax districts, requiring 804 maps and 57 index sheets. These maps are to be bound

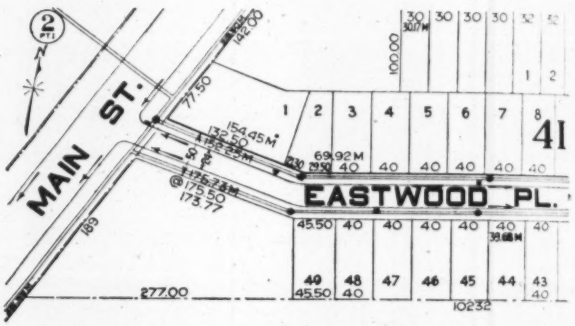


FIG. 2. PORTION OF ASSESSOR'S MAP MADE BY CITY SURVEY DIVISION, BUFFALO

in loose-leaf fashion in 38 parts. The maps are drawn on mounted reinforced Paragon paper sheets 28x36 in. to a scale of 1 in. = 50 ft. On these maps are shown the sublots and their dimensions. Distances from deeds are marked with the letter "D," and measured distances with the letter "M." The original farm-lot numbers are shown in red; the block and sublot numbers are also shown, to assist the assessors in the location of sublots, which are described by block and sublot numbers with particular reference to a certain subdivision map on file in the County Clerk's office.

All existing sewers, manholes, catchbasins and street lights (electric and gas), all of which are paid for in the City of Buffalo by local assessment, are shown on these maps; arrows indicating the direction of the street surface drainage are also shown. Fig. 2 is an example of a portion of such a map. Numbers inclosed in circles at the extreme right and left of the sheet as well as the top and bottom indicate the numbers of the adjoining sheets so as to obviate the necessity of referring to the index page.

As to the disposition of surpluses and shortages in city blocks, it has been found impracticable to apply any set rule that would fit all conditions. In the readjustment

of property and street lines the work is governed to a great extent by existing local conditions. In open country it is comparatively a simple matter to apportion the surplus or shortage over the entire block without causing any material inconveniences.

In many instances lands have been subdivided and maps placed on file in the county clerk's office which indicate that the lots are to be described as being a definite distance from a fixed point of beginning, each lot having a definite frontage except the last lot, which is of a frontage more or less, the evident intention being that the last lot shall bear the surplus or shortage, whichever it may be. In thickly settled portions of the city the property lines are too firmly fixed by reason of long occupation to admit of any radical changes.

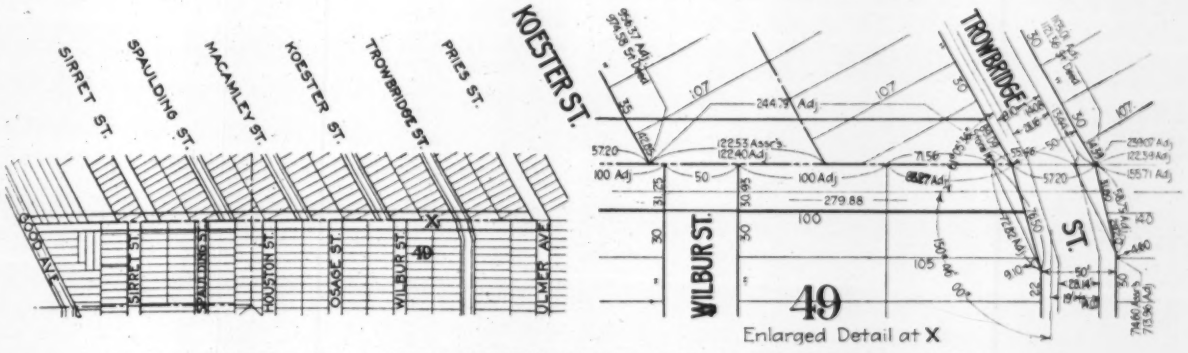


FIG. 3. EXAMPLE OF A SPECIAL SURVEY OF THE CITY SURVEY DIVISION, BUFFALO, N. Y.

In the course of the resurvey of the city, in many localities conditions have been met in which a lot will have an excessive frontage at the expense of another lot some distance beyond in the same block. To attempt a readjustment of the property lines so as to place the excess where it rightfully belongs would cause every intervening property holder to encroach on his neighbor's land, thus giving opportunity for endless litigation far in excess of the value of the land involved. In such cases it is believed preferable to accept conditions as they are.

Wherever it is practicable, an attempt is made so to adjust the property lines as to give every property owner the frontage his deed calls for, even though the readjusted location may disagree with the deed description so far as it refers to the distance from the point of beginning. The Board of Assessors has a record of every piece of property in the city, giving the owner's name, the dimensions of the lot, its location, and land valuation, as well as valuation of improvements. The assessors prefer to use the deed frontages unless objection is made by the owner that the deed frontage is incorrect, when after verification by the Department of Public Works the corrected frontage is used and the changes are made on the map and book of records.

Besides conducting the city survey above outlined, the City Survey Division is constantly called upon to make special surveys for various city purposes, all the survey work of the city being concentrated in this bureau. Fig. 3 reproduces part of the map of such a survey, and incidentally shows a condition of lot layout—incipient city planning—of a particularly flagrant variety. The survey is for a new street to take care in some measure of the haphazard layout of the original sections and blocks of adjoining real-estate developments. The plan at the left shows about half the map in simplified form, while a detail is reproduced in full at the right. The data gleaned in these special surveys are of course made use of for the plans of the systematic city survey.

Buffalo contains about 40 sq.mi., and half of this area has been surveyed. The City Survey Division is in charge of Louis H. Rathmann, Assistant Engineer of the Bureau of Engineering, Department of Public Works, of which George H. Norton is Chief Engineer. The division comprises an assistant engineer in charge of the field party, a transitman, three rodmen (or chainmen) and two draftsmen.

Reservoir-Capacity Table

By Arthur T. Clark*

In locating water-works distribution reservoirs on sloping ground it is often convenient to know in advance the dimensions of reservoirs of different depths that will give a required capacity. The accompanying table has been prepared by the writer to show the capacities of square reservoirs of different depths with different side lengths and with different interior slopes. L is length along water edge.

CAPACITIES OF SQUARE RESERVOIRS (MILLIONS OF GALLONS)

L	D = 10 ft.	D = 20 ft.	D = 30 ft.	D = 40 ft.
Interior Side Slope, 1 on 3 (cot θ = 3.0)				
100	0.4			
200	3.0			
300	5.5	8.8	10.5	11.1
400	11.0	17.5	22.5	25.5
500	16.5	29.1	38.3	44.6
600	25.0	44.0	58.5	70.0
700	33.6	61.4	84.1	102.1
Interior Side Slope 1 on 2½ (cot θ = 2.5)				
100	0.4			
200	3.0	2.81		
300	5.6	9.5	11.8	13.0
400	11.2	18.8	24.5	28.0
500	16.9	30.4	40.9	48.5
600	25.0	45.8	62.2	75.9
700	34.1	63.3	88.1	108.7
Interior Side Slope 1 on 2 (cot θ = 2.0)				
100	0.5	0.6		
200	3.2	5.4		
300	5.9	10.2	13.2	15.1
400	11.6	20.0	26.4	30.5
500	17.2	31.7	43.7	53.5
600	25.9	45.9	62.1	76.0
700	34.6	65.2	92.2	115.6
Interior Side Slope 1 on 1½ (cot θ = 1.5)				
100	0.5	0.8	0.8	
200	3.3	6.1	7.7	
300	6.1	11.4	14.7	17.6
400	11.8	21.2	28.4	33.0
500	17.6	33.1	46.6	58.3
600	26.0	49.2	70.4	87.8
700	35.1	67.2	96.4	122.9

The table is also readily applied to circular reservoirs; if L is diameter, capacity is 0.7854 given value. The

*Assistant Engineer to Robert E. Horton, 57 North Pine Ave., Albany, N. Y.

table can be applied to rectangular reservoirs that are not square by adding a water prism $L' - L$ wide, D high and of length $L - D \cot \theta$, where L' is the long side (water edge) and θ is the angle of bank slope.

If it is desired to obtain the dimensions of reservoirs of a given capacity more closely than they can be taken from the table or read by interpolation, curves can readily be constructed by plotting the data given in the table.

Paving Records; Topeka, Kan.

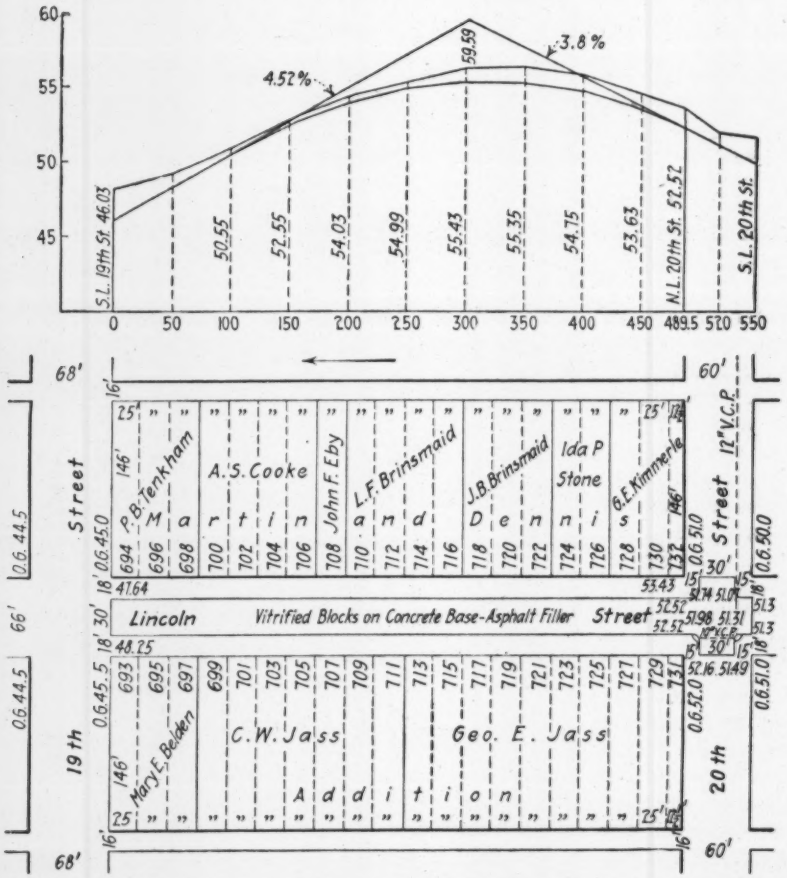
The city engineer of Topeka, Kan., A. R. Young, has adopted the following methods of making and keeping records of pavement construction: A plot of the block or paving district and a profile of the street are made on a single 18x22-in. sheet, of which the accompanying illustration is a small-scale reproduction. These plots are on tracing cloth, divided half and half into plain and standard Plate A cross-section tracing cloth. The scale used ordinarily is 50 ft. 1 in.

These plots serve the double purpose of appraisers' maps and office records. They show all lots and pieces of land in the block or paving district. The file blueprints (described later) also contain in red ink the assessed valuations of the property. Assessments are based on the value of property, not on pro rata frontage alone.

The plots are made by a draftsman, and then boundaries and dimensions are checked twice—once by the office engineer and then by the city engineer. The profiles are plotted from carbon copies of field notes as the fieldwork progresses. The grade lines are put on the profile by the assistant engineer in charge of field work. They are checked and approved by the city engineer and eventually by the Board of Commissioners (Topeka has commission-plan government). Cross-sections, paving areas, curb lengths and other quantities are checked by the office engineer as well as by the field party. All computations are made in bound books, and the record shows the date and initials of the computer and the checker.

As soon as the quantities for each block or paving district are computed, the work as a whole is totaled, the proposal blanks filled out and the contract advertised and let. After the contract is awarded, the detailed estimates of the assessments for each district separately are made, based on the contract prices. Standard forms are provided for these estimates. The computations are made by the office engineer, checked by the assistant engineer in charge of fieldwork and finally checked by the city engineer, who certifies them and transmits the sheets to the city clerk.

By the time this work is done, in ten days or two weeks, the contractors are ready to begin construction. The program starts promptly near the beginning of the new year, and the contractors are at work as soon as weather conditions permit in the spring. There is little trouble in Topeka from contracts delayed until the approach of winter. Blueprints are made of all the plans of the year's work and are bound into books. Near the corner of each tracing has been added a tabulation giving the name of the contractor, date of starting work and the date of completing work, and also a list of the quantities estimated and measured (final) and the unit contract price, all work being let on a unit-price basis. In addition to the plots the file book contains a quantity summary sheet and summary sheet of bids and estimates.



SHEET FROM BOOK OF PAVEMENT RECORDS, CITY ENGINEER'S OFFICE, TOPEKA, KAN.
Actual size, 18x22 in.

The quantity summary gives a list of all the pavements laid during the year, under the proper heading as to the type of pavement, and the final estimate quantities of excavation (cu.yd.), paving (sq.yd.), curb (lin.ft.), paving relaid (sq.ft.), curb reset (lin.ft.), catchbasins, sewers (lin.ft.), concrete walk (sq.ft.), new brick walk (sq.ft.), old brick walk relaid (sq.ft.), manholes, inlets, etc., in each district or block.

The summary sheet of estimates and bids is an extremely valuable part of the file. It contains under the proper heading as to type of pavement a list of all the items bid on during the year. (It is the custom in Topeka to let all the paving of a chosen type or kind in one contract, with the provision that the work is not to be sublet.) The city engineer's

estimate of unit prices and totals is given in parallel columns with each bid received, divided in the same way into unit price and total. The name of the contractor is given in each instance, with an asterisk for denoting the successful bidder. The value of this tabulation, not only as a part of the record, but for making future estimates, can be easily appreciated.

Some Costs of Applying Mortar With the Cement Gun*

The upstream face of the Elephant Butte dam of the United States Reclamation Service is being waterproofed with portland-cement mortar mixed in the proportion of one part cement to two parts sand and applied with a cement gun in a coating about 1 in. thick. Advantage has been taken of rising water in the reservoir to work from rafts specially constructed for the purpose. There are two of these, each 9x13 ft., made of planking on a framework laid on and attached to 16 oil barrels. One raft contains the machine, operator and helpers, small mixing box and a few sacks of cement and sand, while the other is loaded with cement and sand.

The coating is applied in horizontal strips about 10 ft. high and the length of the dam at water level. The surface is first cleaned thoroughly with scrapers and wire brushes and is then gone over with a sand-blast, using coarse sand, passed through the machine to obtain the necessary pressure. This roughens the surface sufficiently to cause the mortar to adhere to it. The surface is then thoroughly moistened with a hose and the mortar immediately applied. The mortar is put on in four layers, each about ¼ in. in thickness. It was found that a thicker coat than this applied on a vertical wall, without reinforcement, would, on account of its weight, slough off before setting. Each layer follows the preceding one before it has attained its final set, and so far there is no indication of a parting of the layers. Numerous samples taken from the face showed perfect adhesion to the concrete, it being impossible in every case to break the mortar from the concrete at the line of contact. The cost per square foot for the first 100,000 sq.ft. of this coating is as follows:

Operating and repair work, including cost of air and water	$0.015
Staging, cleaning wall, moving, etc.	.006
Cement	.024
Sand, including labor, screening and hauling (sand only 20c. per cu.yd.)	.007
Depreciation of gun and equipment	.020
Subtotal	$0.072
Overhead	.007
Total cost per square foot	$0.079

Some experiments were also conducted at Elephant Butte to determine the feasibility and probable cost of troweling the mortar placed by cement gun, with the idea of using the machine for the lining of canals or for repairing lining that had disintegrated and required a smooth finish. The area treated was 75 sq.ft. This was covered with mortar averaging ¾ in. in thickness in 15 min. working time, or at the rate of 300 sq.ft. per hr. for this average thickness. One good finisher troweled 56 sq.ft. in 25 min., or at the rate of 135 sq.ft. per hr. Possibly two men could keep up with the gun. The finishing was not done to a screeded surface. The surface is wavy, but much smoother than a formed surface would be. It could be screeded to a plane, if thought necessary. Care must be taken that too much material is not deposited in one coat, or horizontal cracks will occur, due to settlement. Some cracks appeared in this experiment, and in each one the material was found to be from 1 in. to 1½ in. thick. The cost of this particular experiment, not counting cost of setting up, equipment, etc., was as follows:

Labor	$0.30
Sand, approximately 9 cu.ft.	.90
Cement, 4 sacks	2.00
Total for 75 sq.ft.	$3.20
Per square foot	$0.04¼

Depreciation, staging, moving, etc. would depend on the job, but it is probable that the total cost of placing this coating, including the troweling, under average conditions would not exceed 5c. per sq.ft.

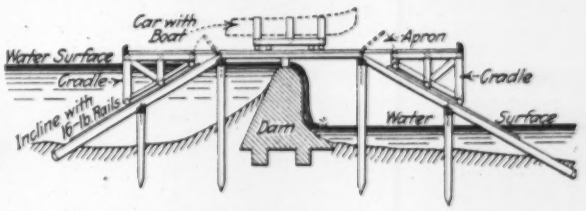
In using the cement gun the sand must be clean, sharp and not too fine. It must not be bone-dry, or trouble with feeding will occur. The air pressure should be about 30 lb. in the gun and the water pressure over 60 lb. It has been figured at Elephant Butte that 30 ft. of free air at 100 lb. pressure at the point of delivery to the gun and 10 gal. of water are required per minute.

*From the "Reclamation Record," March, 1916.

Marine Railways for Hauling Boats Over Dams

Improving the Fox River in Illinois by means of dams is proposed by the Illinois Rivers and Lakes Commission in order to maintain a slack-water level in stretches that are now extremely shallow in dry-weather periods. There is considerable use of the river for pleasure boating, and in order to get boats from one level to the other it is planned to equip each dam with a simple type of marine railway.

The general construction is explained by the drawing. On each side of the dam is an incline with track for a



MARINE RAILWAY FOR PASSING BOATS OVER DAM ON THE FOX RIVER, ILLINOIS

cradle, having a level platform and a track for a car. The cradle, with car upon it, is lowered beneath the water and the boat floated into position on the car. The cradle is then raised and the car rolled across to the cradle on the opposite side, which is lowered into the water. Hinged aprons connect the cradles with the deck of the fixed trestle.

The marine railway would rarely cross directly over the dam in the manner shown. In most cases the incline on the upstream side will be upon the bank, near the end of the dam. Thence the car will run on a narrow-gage track to a suitable point below the dam, where the second incline can be placed. Where there is a headrace, this may provide a location for the inclines. The cost for these marine railways is estimated

at $1,000 each, or $11,000, with $53,960 for dredging at the foot of the downstream inclines. Thus the total cost would be $64,960. The cables of the cradles would be operated by drums driven by electric motors, as electric power is available at most of the dams. Hand operation could be employed where necessary.

A marine railway of this type, but large enough to handle a canal boat 100x17 ft., is being built by the Spring Lake Drainage District, in Illinois. This was ordered by the courts, as the District's levee closed a channel connecting Spring Lake with the Illinois River. The boats will be taken up one incline on a cradle, then turned 180° on a turntable and lowered on the other side.

Town Improvement Records Kept in Card Index

A card-index record of public improvements done by special assessment has been devised by Morgan H. Brightman, city engineer of Elgin, Ill., and was described in a paper presented at the recent annual meeting of the Illinois Society of Engineers. In view of the continual demands for information as to work of this kind the record was prepared to eliminate as far as possible the necessity of frequent reference to original records and also to condense the information to convenient form.

The principal facts and figures concerning the different improvements are recorded on the two sides of standard 4x6-in. filing cards, as shown by the accompanying illustration. One card is used for each improvement. The entire system, alphabetically arranged and filed in a small metal case, occupies an inconsiderable space in the office desk.

In the first four lines on the face of each card a considerable amount of information regarding the improvement itself may be given. For a brick pavement, after the name of the improvement would appear the street in which the work was laid, the points to and from which it extended, the length and width of roadway, nature and thickness of base, make of brick and kind of filler, together with the yardage of pavement and the lineal feet of curb or curb and gutter, and any other quantities of major importance.

CITY OF ELGIN

Special Assessment Improvement Record Card

Morgan H. Brightman, City Engineer

Name .....

Extent .....

Kind .....

Quantity .....

Contractor ..... Address .....

Engineer ..... Assessor .....

Est'd cost of construction $ ..... Public Benefit $ ..... Per Cent ....

Est'd cost of assessment $ ..... Property Benefit $ ..... Rate ....

Total Estimated cost ....$ ..... Total Roll ....$ ..... Installments .....

Contractor's bid .....$ ..... Reduction ....$ ..... Per Cent .....

Extras .....$ ..... Reduced Roll ...$ ..... Reserved .....

Total cost of construction $ ..... Contractor'sBond$ ..... Guarantee .....

Contract Record ..... File ..... Plans ..... Preliminary Notes .....

Docket ..... Ordinance ..... Profiles ..... Construction Notes .....

CARD FOR RECORD OF SPECIAL-ASSESSMENT IMPROVEMENTS AT ELGIN, ILL.
Card 4x6 in.

On the reverse of the card the column headed "References" is used to good advantage for noting initials and numbers referring to minutes of board meetings, official proceedings, etc., that may be connected in some way to the date opposite. For instance, opposite the date of the adoption of the first resolution the note "B. L. I. III. 125" means that on page 125, Vol. III of the proceedings of the Board of Local Improvements is recorded the adoption of such resolution. The note "D. N. 1/16-1/26" opposite the date of the advertisement for bids would indicate that such advertisement was officially made in the *Daily News* from Jan. 16 to Jan. 26. In this way each card furnishes a record of the bulk of the general data relative to the improvement which it represents. Occasional reference must still be made to more detailed and complete records for information that could not possibly be noted on the cards.

Date of	Month	Day	Year	Reference
1st Resolution				
Notices mailed				
Public hearing				
2nd resolution				
Ordinance passed				
Petition filed				
Roll filed				
Notices mailed, etc.				
Hearing on roll				
Roll confirmed				
Advertisement for bids				
Bids received				
Contract awarded				
Work commenced				
1st voucher				
Work completed				
Approved by Board				
Certificate of costs, etc.				
Notices posted, etc.				
Accepted by Court				
Final voucher				
Roll reduced				

REMARKS:

REVERSE OF CARD

To facilitate this further reference work, blanks are provided on the face of the card, at the bottom, to be filled in with court docket number and the file or index numbers referring to other records in the engineer's office, including field notes, plans, profiles, specifications, ordinances, contract records and copies of all legal or other papers and documents connected with the improvement. An index letter and number are placed at the upper corners of each card to aid in filing and for cross-referencing.

Experiments on the Effect of Hydrated Lime on Concrete

The Committee on Mixing and Placing of Concrete of the National Conference on Concrete Road Building, which met in Chicago, Feb. 15-18, reported some tests that had been made at Milwaukee in the investigation of the proper methods of mixing and placing concrete for roads. Among those tests are a few that throw some light on the question of the value of hydrated lime in concrete. A portion of the report, by Ernest Ashton, of the Lehigh Portland Cement Co., Allentown, Penn., relates to the hydrated-lime investigation. In his report Mr. Ashton says:

> A small amount of work was done to ascertain whether certain statements made relative to the use of hydrated lime were correct, among which the following questions were most pertinent:
>
> 1. Does the addition of hydrated lime increase the mobility of concrete?
>
> 2. With a given angle of chuting and given percentage of water, will concrete flow more readily if hydrated lime is added?
>
> 3. Does the addition of hydrated lime aid in preventing segregation?
>
> 4. Acting as a void filler, will the addition of hydrated lime tend to make the mass more impervious, thereby reducing to the minimum alternate expansion and contraction due to moisture?

A résumé of the results of the tests is given in the accompanying table. The concrete was mixed in a machine mixer and deposited in the molds after being mixed 1 min. and after flowing through a short concrete chute on an angle of 20°. The same methods of manufacture and storage were used on all the specimens. The column headed "Consistency" in the table is somewhat ambiguous, but is the best application that can be deduced from the report.

Further remarks regarding the specimens are that in specimen H-5 there was no separation of materials and that all specimens were poorly compacted; specimen H-10 was more sticky than H-5, and in two of the three tests on which the average was taken was fairly well packed, the other being poorly packed. Specimen H-15 was still more sticky than specimen H-10, and all materials held well together in a mass. All the specimens, however, were poorly compacted. In specimen H-145 the concrete was very soft and easy flowing. In specimen H-1410 the concrete was not so soft as in H-145, but the flow was slower. Of specimen H-1415 the appearance and the flow were the same as of H-1410. Mr. Ashton's conclusions regarding the tests are as follows:

1. No greater freedom of movement of the mass was noticed. In point of fact, as the lime was increased, more difficulty was experienced in getting material into the test forms.
2. The work done shows that, with the same angle and the same percentage of water, concrete did not flow more readily with the addition of hydrated lime; and as the percentage of hydrated lime was increased, the mass became more sticky and did not flow as readily.
3. By far the most important observation made was that the addition of hydrated lime did prevent segregation, so much so as to make the biggest gain that can be derived from the use of hydrate of lime.

Mr. Ashton adds further that the number of specimens made was too small to allow an adequate interpretation of actual values. It is the intention of the committee to carry on during this year a more extensive investigation as to the value of adding hydrated lime. In this connection attention is called to the fact that the Bureau of Standards in Pittsburgh has already started some work along this line.

TESTS OF 6x12-IN. CONCRETE CYLINDERS WITH VARYING AMOUNTS OF HYDRATED LIME AND OF WATER*

No.	% Lime	Lb. of Water per Cu.Ft. of Material	Consistency	Compression,† Lb. per Sq.In. 1 Mo.	2 Mo.
H-5	5	5.3	Sticky	4,090	4,580
H-145	5	6.5	Very easy flowing	2,880	3,250
H-10	10	5.3	Quite sticky	4,630	5,330
H-1410	10	6.5	Quite easy flowing	4,290	5,020
H-15	15	5.3	Very sticky	4,420	5,150
H-1415	15	6.5	Quite easy flowing	4,210	4,620

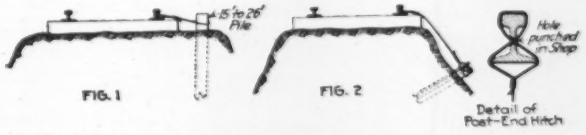
*Tests made on 1 : 2 : 3 gravel concrete. Hydrated lime measured as an added percentage to the weight of cement. Constant slope of chute, 20°; time of mixing, 1 min. †Each figure is the average of three specimens.

Railway-Track Anchors

How to keep a railway track on a fill subject to overflow is one of the problems railway maintenance-of-way engineers sometimes have to face. Two methods have been successfully used on the Missouri, Kansas & Texas Ry. in the Southwest.

The first is illustrated by Fig. 1. Piles are driven 15 to 26 ft. through one shoulder of the fill at intervals of 100 ft. The track is anchored to these piles by galvanized-iron wire looped under and around the tie nearest the pile, being held by the inside flange of the rail. Track anchors of this description saved over two miles of overflowed track in the Brazos Valley, Texas, in the spring floods of 1915. Since then track anchors have been used in many localities on this line. The type described is objectionable for several reasons: It is costly, the anchors are too far apart, and the wire buried in the ground at the ends of the ties rapidly rusts out.

Another form of track anchor which is giving satisfaction is shown in Fig. 2. This consists of pieces of old rail 5 or 6 ft. long driven perpendicular to the slope of the fill. The sections of rail are cut and punched at the shops and are placed by section gangs. The hole is first started with a post-hole auger, and then the rail is driven home with a similar section of rail swung, or raised and dropped, by two men—one at each end. These rail posts are driven every two rail lengths, or every 66 ft. There is a hole punched near the top of the post, and through this a ⅜-in. galvanized wire guy line (or wire rope) is passed, as shown in the little detail, Fig. 2. This line passes over the shoulder of the fill and is fastened to the track, as in Fig. 1.



RAILWAY TRACK ANCHORS, MISSOURI, KANSAS & TEXAS RY.

The foregoing data were obtained from A. A. Matthews, Engineer of Maintenance-of-Way, Missouri, Kansas & Texas Ry., Dallas, Tex.

Cost of Cement Testing

By Frank H. Carter*

It recently became the duty of the writer to equip and install a small-cement-testing plant to handle about 5,000 bbl. of cement. The cost of the apparatus, together with a statement as to the cost of the testing, per barrel, forms a basis for an interesting comparison of the cost of the same work by cement-testing laboratories.

COST OF APPARATUS

1 enamel pan	$0.55
1 5x5-in. glass	.10
1 2-qt. kerosene can	.05
1 bottle	.05
1 funnel	.15
1 funnel	.05
1 enamel pan	.55
1 piece glass	.40
8 pieces glass	.32
1 thermometer	.50
1 50 sieve 1 100 sieve 1 200 sieve 1 20 sieve 1 30 sieve	19.00
1 one-section mold	3.20
1 two-section gage mold	6.40
1 three-section gage mold	3.60
1 testing machine	144.00
1 Vicat needle	16.00
1 specific-gravity bottle	2.75
1 keg sand	6.25
	$209.92
Cost per barrel ($209.12 ÷ 5,000)	4.20c.

The time required for the various operations is shown in the appended table:

	Hr.
"Normal consistency"	1
Determining per cent. on 100 sieve	1½
Mixing batch for forms	1½
Breaking 30 briquettes (10 min. for each)	5
Sampling from carload	2
Specific-gravity determination	½
Mixing cement for composite sample	¼
Obtaining water	¼
	12

*Designing and Supervising Engineer, Cliftondale, Mass.

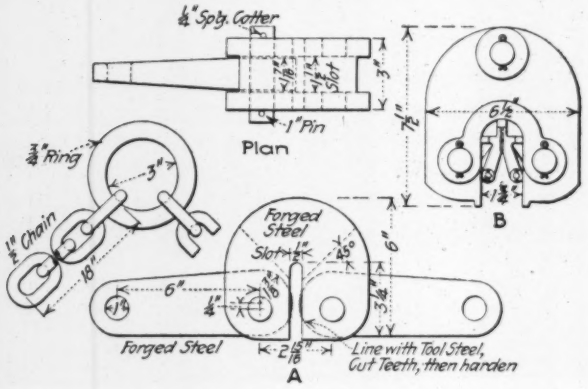
The operator was paid $15 per week of 48 hr., or 31.3c. per hr. As he could test 200 bbl. of cement in 12 hr., there was a wage charge of 1.87c. per bbl. The first cost of the apparatus, per barrel of cement, was 4.20c., which makes the total cost per barrel 6.07c. The apparatus is, however, on hand for use by the city engineer's department.

The operator had no previous experience whatever in cement testing before doing this work and was "broken in" by a recent graduate who had taken a laboratory course in cement testing. It should be stated, in view of the low cost of doing this work, that the operator was employed on the force-account cost data when not engaged in testing cement, and his time while on that work was deducted from the cost of the cement testing.

Clamps for Pulling Steel Piles

In pulling steel sheet piling the use of a hook in a hole in the pile is not always effective, as the hook may tear through the metal without loosening the pile. Two forms of clamps designed to give a sure grip on the pile are shown herewith. They are manufactured by the Vulcan Iron Works, Chicago.

In the design shown at *A* the web of the pile is gripped between the eccentric cams formed by the ends of two



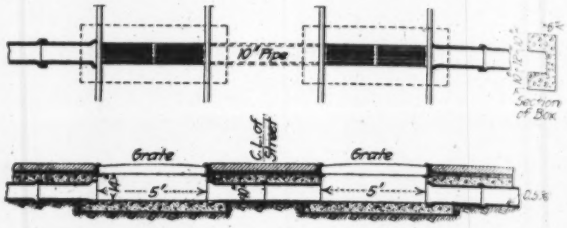
CLAMPS FOR PULLING STEEL PILES

levers journaled in a heavy steel forging. A chain sling is attached to the outer ends of the levers; and as the pulling strain is applied to the sling, the serrated faces of the cams grip the web between them. In the second design *B* the arrangement is more compact. The two jaws, or grips, are carried by arms pivoted in the horse-shoe frame, so that the downward pull on the jaws (due to the resistance of the pile) tends to draw the arms inward, thus forcing the jaws together.

NOTES

Roof Trusses Spaced Close to Carry Shafting—In a new shop building just being erected for the Fox Machine Co. at Jackson, Mich., which has three 30-ft. bays, the roof over the side bays is carried by trusses spaced 8 ft. on centers. The columns, both wall and interior, are spaced 24 ft., and longitudinal trusses extend between them to carry the side-bay trusses. The close spacing of the trusses was adopted with a view to providing for the support of shafting and of pipes for heating and ventilating. The bottom chords are made of two channels spaced 1 in. apart back to back. The pipes rest upon them, and the shafting hangers are attached below. No intermediate supports are required. The managers believe that changes in shafting arrangement, as required when shifting a machine to another location, will be greatly facilitated by this fact.—A. Brett.

Culvert Under Street with Car Tracks—A surface-water drain for streets having no storm sewers sometimes has to cross a street with car tracks. It is common practice in a number of Western cities that have no storm-water sewers to build surface-water drains as deep gutters and to carry

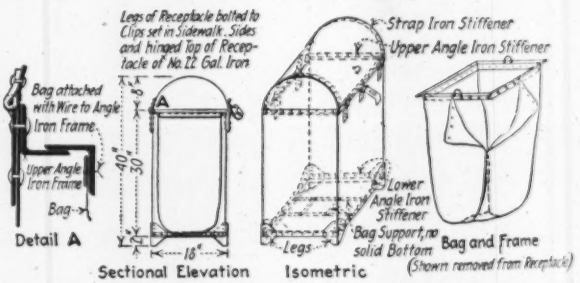


CULVERT FOR CARRYING STORM WATER ACROSS STREET WITH CAR TRACKS

them across street intersections by a dip or gully, through the crown of the cross-street. This plan is obviously bad from the point of view of traffic and of course impossible where the cross-street has car tracks. Fort Worth, Tex., has no regular storm-sewer system. What surface water does not run in the gutters is conducted into drains laid under the gutters or under the sidewalk parking. From these it either runs out into the gutters again at low points or is conducted into a few specially constructed storm sewers. To get across streets with car tracks, the construction shown in the accompanying sketch is used. The cast-iron grating rests on the rail flanges and is loose enough to be conveniently removed for cleaning the concrete culvert. The same type of grating and inlet is used where there is a sump or low spot in the railway-track area to be drained. There is an apparent benefit in storm-water drains laid under the gutters on both sides of the street—that is, the facility afforded of draining the pavement foundation. Fort Worth has some excellent wood-block pavement laid on a 1½-in. sand cushion and with sand-filled joints, which have never given any trouble from expansion or bulging. The street thus paved has a storm-water drain under each gutter, and it is not unlikely that this has served to keep both the subsoil and the sand cushion perfectly drained. F. I. Von Zuben is City Engineer of Fort Worth.

The Engineering Library of the Civil Engineers Society of St. Paul has been given to the St. Paul Public Library to be used as the nucleus of a notable technical reference library. This donation consists of 1,100 volumes, including many valuable reports and periodical files.

Street-Refuse Receptacle—The accompanying sketch illustrates a new type of street-refuse receptacle designed by the office of the Director of Sanitation (Charles Saville), Dallas,


Legs of Receptacle bolted to Clips set in Sidewalk. Sides and hinged Top of Receptacle of No. 22 Gal. Iron
Strap Iron Stiffener
Upper Angle Iron Stiffener
Bag attached with Wire to Angle Iron Frame
Upper Angle Iron Frame
Bag
Detail A
40"
30
18"
Sectional Elevation
Lower Angle Iron Stiffener
Legs
Bag Support, no solid Bottom
Isometric
Bag and Frame (Shown removed from Receptacle)

STREET-REFUSE RECEPTACLE DESIGNED BY THE BUREAU OF SANITATION, DALLAS, TEX.

Tex. It is made of 22-gage galvanized iron, properly painted and labeled. It is reinforced top and bottom with angle-iron stiffeners. The cover is a semicylindrical hood open at the ends. The receptacle is placed parallel to the sidewalk, with the supposition that people will cast refuse in at the ends as they pass. The receiver is a detachable bag, which with its frame may be removed and emptied. The price of a sample receptacle was $7, but in buying in quantity the price would be much less.

Editorials

How Civilian Engineers May Study Military Practice

Since a course of lectures on military science was enthusiastically entered upon by over two thousand engineers in New York City, as noted in these columns, we have received some requests from engineers in other localities to reprint the New York lectures or to publish a series of articles by some recognized military authority, covering the same ground. The reasons why we have not thought it best to do this is that the matter presented in these lectures and in any such series of articles, if it is really to educate engineers for practical military work, must be extremely elementary, from the military standpoint, and must therefore be based directly or indirectly on published textbooks readily available to anyone.

The same ground that such lectures attempt to cover can be covered even more completely by a brief reading course. Indeed, such a course has now been recommended for those attending the New York lectures, and we understand that the committee in charge of these lectures will probably advise those attending the lectures to follow such a course instead of reprinting the lectures for them.

Instead of taking space in these pages for such elementary textbook matter, therefore, which would necessarily have to be given in much abbreviated form, we can render our readers greater service by recommending a list of books suitable for home study and equally available for the engineer out of reach of any center where military lectures may be attended or for the engineer who wishes to supplement his attendance on lectures by the study of textbooks. The following books are selections from a list drawn up by the Chief of Engineers of the United States Army, with two other recommended works. The full list will be printed in the next engineering-literature section of *Engineering News*, Mar. 16, 1916.

On Military Policy and the Conduct of War—"Field Service Regulations, 1914"—United States Army (may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C.; 60c.). "Elements of Strategy"—Fieberger. United States Military Academy (obtained from the book department of Army Service Schools; 75c.).

On the Organization and Duties of Engineer Troops—"Studies in Minor Tactics, 1915"—Army Service Schools (may be obtained from the book department of the Army Service Schools, Fort Leavenworth, Kan.; 50c.). "Infantry Drill Regulations"—United States Army (may be obtained from the Superintendent of Documents, Government Printing Office; 60c.).

On Field Engineering—"Notes on Field Fortifications"—Army Field Engineer School (may be obtained from the book department of the Army Service Schools, Fort Leavenworth, Kan.; 30c.). "Engineer Field Manual"—Corps of Engineers, United States Army. Third edition, 1909 (may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C.; $1). "Military Topography for Mobile Forces"—Sherrill. Second edition (may be obtained from the publisher, Banta Publishing Co., Menasha, Wis., or the book department of the Army Service Schools, Fort Leavenworth, Kan.; $2.25).

On the Coast Artillery—"The Service of Coast Artillery"—Hines and Ward (may be obtained from the publishers, Goodenough & Woglam Co., 122 Nassau St., New York City; $3.50).

Can Rock-Fill Dams Stand Up Under Overflow

The conditions necessary in the construction of a rock-fill dam, in order to make the structure safe, were discussed editorially in the issue of Feb. 10, in connection with the recent disastrous failure of the Lower Otay dam near San Diego. A later detailed report of the Otay dam failure, by Roy A. Silent, was printed in the issue of Feb. 17, and elsewhere in the current issue is published a series of papers presenting the views of four engineers on the design of rock-fill dams.

The disastrous failure at Otay should not discredit the rock-fill dam as a type. There are unquestionably many locations where a rock-fill dam can be built more cheaply than any other type. There are places where the cost of the cement necessary to build a masonry or concrete structure would be prohibitive. There are places where the rock available at the site or within reasonable distance would be unsuitable for use in a masonry structure and yet would make a substantial rock-fill. The rock-fill again has notable advantages in a country subject to earthquake shocks. It is important, therefore, for any engineer interested in dam construction to know exactly what happened in the Lower Otay dam failure and what lessons in the design of such structures are to be drawn from that disastrous occurrence.

The account of the dam's failure, by Mr. Silent, confirms with somewhat greater detail the earlier story by John W. Bacon in the issue of Feb. 3. It deserves thoughtful study in connection with the careful analysis of the stresses and the conditions in the interior of a rock-fill dam subject to overflow, given in the paper by Ralph Bennett elsewhere in this issue.

According to Mr. Silent's report, the rising water of the reservoir reached the crest of the dam at 4:45 p.m. At that time water was escaping from the reservoir through the spillway at a rate of 2,400 cu.ft. per sec. and also through a 48-in. outlet pipe under a head of about 80 ft. What the rate of rise of the water in the reservoir was at that time is not known; but it cannot have been rapid, for the reservoir covered an area of 860 acres. Other figures in Mr. Silent's paper indicate that the reservoir level rose at the average rate of about 7 in. per hr. on the day of the failure. The sequence of failure was as follows: The water reached the top of the dam at 4:45 p.m. This water apparently percolated down through the rock-fill and five minutes later was issuing in small streams from the lower face near the bottom and starting the caving of this lower face. This rock-fill then "quickly melted away," leaving the core wall unsupported, so that the water pressure on the upper side tore it in two at 5:05 p.m.

It appears from these figures that the destruction of the rock-fill must have taken place with a depth of not over 2 in. of water flowing over the crest. Such a "melting away" of a huge pile of rock can only be accounted

for by taking into consideration the pressure to which it was subjected as a structure, as well as the water flowing through it. The mere falling by gravity of a thin sheet of water, not over a couple of inches in thickness, through this loose rock-fill, had it been standing by itself, would have had no effect upon it. The engineer who should attempt to excavate a pile of such rock by simply pouring a stream of water on the top would find no results from his efforts. In order to account therefore for the very rapid settlement of the Lower Otay rock-fill under this trifling amount of water the heavy stress to which the whole mass was subjected must be considered—a stress undoubtedly approaching its crushing strength. The water percolating through the mass acted as a lubricant and also by the hydrostatic pressure set up in the lower part of the dam helped to force out the rocks on the lower face of the fill, which were in unstable equilibrium anyway by reason of the steep slope on which they lay.

In the very interesting analysis of various rock-fill dams, given elsewhere by Mr. Sellew, reference is made to the coefficient of stability, or the quotient of the total weight of the rock mass divided by the water pressure against it. This coefficient should not be confused with the coefficient of friction of a concrete or masonry dam, to resist sliding upon its base. So far as sliding is concerned, the resistance of a rock-fill dam with its rough surfaces is doubtless greater than that of a masonry dam, which may slide upon a smooth base, as did the unfortunate dam at Austin, Penn.

The failure of a rock-fill dam, as illustrated by the Lower Otay, appears to be a gradual yielding or settlement of the whole mass of broken rock. Such yielding and settlement have been noted in rock-fill dams to a small extent under pressure alone, without the action of water upon the mass. At the Lower Otay the lower face of the dam was so steep that the rocks lying on it were about ready to slide. The pressure of the full reservoir, when combined with the lubricating and hydrostatic action of even a small amount of water in the rock mass, was sufficient to start this lower face to sliding and caving to such an extent that within ten minutes the rock fill had settled down so far that the core wall projecting above could not stand the pressure against it.

If the results at the Lower Otay were to be the sole guide, it might be concluded that the rock-fill dam is even more susceptible to injury, if its crest is overtopped by a flood, than an earth dam. A well-built structure of clay, with its slopes well sodded, would probably have stood considerably more overflow, before eroding to the point of breakage, than did the rock pile at Lower Otay.

On the other hand, some of the early and enthusiastic advocates of the rock-fill dam went so far as to claim that it was especially adapted to resist overflow. Some of the older readers of *Engineering News* may recall the plans of the Nicaragua Canal Co. to control the flow of the San Juan River by building rock-fill dams in its bed, somewhat after the plan adopted by Mr. Corey many years later in damming the flow of the lower Colorado, when it escaped to the Salton Sea. The opposite point of view is presented by some of the contributors to the symposium elsewhere in this issue, who argue that under no circumstances should a rock-fill dam be expected to stand overflow. They contend very properly that for a rock-fill dam, as for an earth dam, ample spillway capacity should be provided to take care of floods.

There is no doubt whatever that ample spillway capacity was not provided at the Lower Otay dam. The area tributary to the Lower Otay reservoir was 139 sq. mi. The spillway located beside the dam was 38 ft. wide and 8 ft. deep. In contrast with this the Escondido rock-fill dam in the same locality collects water from a drainage area of only 8 sq.mi. and has a spillway 25 ft. wide and 5 ft. deep.

But while it is easy to say in the light of recent events that the spillway at the Lower Otay dam was insufficient, what engineer would have been able to prove to the people of San Diego, prior to the recent flood, that the spillway at the dam was inadequate? Remember that in all the 20 years the dam had been standing, the reservoir had never been filled to within 15 ft. of the spillway floor and not a drop of water, therefore, had ever run through the spillway.

Mr. Jorgensen, in his paper in this issue, says that "the covering of the crest and downstream face of a rock-fill dam to enable it to pass a sheet of water without injury would undoubtedly be more expensive than provision of the same discharging capacity in a spillway." There are situations where this would be true. There are other locations, however—such as dams in narrow cañons—where a wide spillway can only be provided at great expense.

The most notable failure of a rock-fill dam prior to the washing away of the Lower Otay dam was that of the Walnut Grove dam in Arizona. It was overtopped by a high flood in the night, and its failure caused the loss of 129 lives. Like the Lower Otay dam, it was built with a very steep downstream slope, which must inevitably have been rapidly washed away when the water passed over it. Had it and the Lower Otay dam been built with flat slopes of, say, 2 on 1, it is quite likely that both might be standing today, notwithstanding their deficient spillway capacity.

It must be borne in mind that in building any dam of this type the engineer must face the question, What is sufficient spillway capacity? In a large part of the arid regions phenomenally heavy rainfalls occur at long intervals. If an engineer were to provide spillway capacity sufficient to care for these very rare rainfalls, he would be censured as extravagant by those furnishing the money for the work. In such cases, however, it may be possible for an engineer to secure the necessary funds to give his dam a reasonably safe downstream slope and place sufficient surplus rock on it so that the mass will stand considerable settlement under the action of water without leaving the water-tight face unsupported and also to protect the slope by more or less regularly laid stones that will stand some flow over them without displacement.

Advantages of Serial Bonds

There is little doubt that the people of the United States are about to undertake much larger expenditures on road construction than ever before, and probably most of the funds for this work will be obtained through bond issues. A bulletin has recently been sent out by the officers of the American Highway Association urging upon county officials that highway-construction bonds should be issued on the serial plan instead of on the more common sinking-fund plan, and at the recent Pitts-

burgh meeting of the American Road Builders' Association a resolution to the same effect was adopted.

The history of sinking-fund accumulations shows not a few cases where moneys have been diverted from these funds to other uses. There is always a chance, greater or less, of defalcation and loss of securities kept in a sinking fund, and the safer plan by far is to apply directly the money collected every year toward the payment of debt. While experience with sinking funds in the hands of municipal and state officials has been unsatisfactory, still worse results would be likely with county sinking funds, for it is pretty well known that the standards of honesty and efficiency in county government throughout the United States average below those in either municipal or state government.

The argument formerly made in favor of the sinking-fund plan was that bankers and investors preferred to purchase long-term rather than serial bonds. Perhaps this was true years ago, but recent experience indicates that bankers and investors prefer serial bonds, on account of their greater safety. An additional argument for serial bonds is the loss that occurs if money that should be invested in the sinking fund is allowed to lie idle in the banks for a time. According to a recently published statement, the average uninvested amount in New York City sinking funds last year was more than $10,000,000.

A further argument in favor of the serial-bond issue is that the interest payments decrease every year with the diminishing principal. In case of bonds issued for road construction, where the expense of maintenance is great, the total value remaining in the road at the end of the usual bond period is problematical. It is especially desirable that the cost of the road should be paid for by those who benefit by it during the period of use and not be left as a burden for the taxpayers to carry after the roads are worn out or require heavy maintenance expenses.

Reducing the Time for Street-Car Stops in Cities

The old saying that time is money is remarkably illustrated by the statement that the Interborough Rapid Transit Co., of New York City, has expended $150,000 on improvements in operating apparatus and methods in order to reduce by one second the duration of the stops of its express trains.

This sum seems an enormous one to spend for a very short saving in time. When, however, one multiplies the number of express-train stops per annum by the number of passengers carried on the average express train, obtaining in this way the aggregate saving of time to the public, and then compares with this figure the annual interest and sinking-fund charges on the investment necessary to save one second in the average express-train stop, he finds that a very small sum is being expended to save the traveling public an enormous amount of time. The same problem may be figured also from the company's point of view as to the value of the time saved in the increased service obtained from the enormous investment in the railway and in rolling stock, and also on the basis of the increased traffic earnings possible on a line now crowded to the limit of its capacity.

It would be of great public benefit if such methods of computing the value of time saving were adopted by the managers of street railways throughout the country. One can see in almost any city in the country, especially those where pay-as-you-enter cars are in use, street cars standing waiting at the corners where traffic is densest while long lines of men and women file on board and the conductor makes change with each successive one for the payment of his fare. Where, however, bunches of tickets are sold at a reduction, as in Washington and Montreal, for example, four passengers out of five walk past the fare box without stopping, dropping a ticket as they pass. The street railways of other cities by selling tickets at enough reduction from the regular fare to cause their general use in the place of cash fares, would profit in the time saved in the movement of the cars. In addition they would gain by the increased use of the cars which results both from the ticket system and from more rapid car service.

Steel Passenger Cars from a British Viewpoint

Nobody in the United States doubts that the steel passenger car has come to stay. In fact, the building of wooden passenger cars in this country has practically ceased. It is surprising, therefore, to learn that in Great Britain the steel car is still looked upon with grave suspicion as a radical and dangerous innovation. The British Board of Trade has been investigating the recent bad accident at Jarrow, where the flimsy English wooden cars were badly smashed. "The Engineer," London, comments on the accident as follows:

> We may turn now to the subject of metal coaches. The all-metal vehicle is an unsatisfactory ideal. It is difficult to construct, is not easily decorated, and is very susceptible to climatic changes. Steel coaches are understood to resist better the evils of collisions and derailments, but they are not without objections that are not found in wooden stock. One does not relish the idea, for instance, of having to be rescued from an all-steel car by an oxyacetylene blow-pipe cutting the sides of the carriage open. The rendering of wood noninflammable is a better idea, and here, again, the London & North-Western has made a move. It has erected at Wolverton a fireproofing plant at a cost, we believe, of about £15,000. This plant consists of two cylinders and the other necessary equipment and can deal with about 150,000 cu.ft. of timber per annum. The Midland Co. has a similar plant.

The recent disastrous rear collision of the New York, New Haven & Hartford R.R., where a passenger train ran past danger signals and struck the rear of a standing express train, has furnished American engineers a new demonstration of the great value of the steel car in safeguarding human life. The car hit was a steel Pullman, and only six of the passengers in it were killed. Had this car been of wood, there can hardly be a doubt that the heavy locomotive would have telescoped it for its entire length. This experience is only a repetition of the history of all recent American railway accidents where steel cars were involved.

Nevertheless, from a British viewpoint the steel car is an "unsatisfactory ideal," and processes for rendering wood noninflammable are "a better idea"! Such processes were thoroughly exploited in the United States a dozen years ago and have been generally abandoned. Why British conservatism should cling to such fads and oppose steel passenger cars is a puzzle we will not attempt to solve, unless it is because of a tenacious respect for the decorative style peculiar to the wooden car architect. The steel car, it will be noted, "is not easily decorated."

Letters to the Editor

Proposes a New Pile Formula

Sir—Concerning A. M. Knowles' article on suggestions for steam-hammer pile formulas: Practical engineers no longer believe that piles can be driven by mathematics; hence, why bother to work out mathematical formulas? In the days of the ordinary drop hammer the old *Engineering News* formula $p = \frac{2wh}{s+1}$ was used. In recent years when placing important pile foundations, no formulas have been used, but instead, the piles have been tested by actual loading before the structure was built upon them.

However, in less important work the engineer no doubt wishes to convince himself that the piles are being driven to the proper penetration to give the required safe load. In this event a suitable formula applicable to the method used in driving the piles is required by some engineers. The formula given herewith has been found very useful by the writer in predicting the safe load on a pile, where the subsoil is known:

$$p = (Sa + R)l$$

in which

p = Safe load per pile, pounds;
S = Skin surface of pile under soil, square feet;
l = Length of pile in ground, feet.

For loam and silt $a = 1.7$, $R = 47$; for moist clay $a = 7.4$, $R = 96$; for sand or clay $a = 19.2$; $R = 203$; for coarse sand and gravel $a = 29$, $R = 300$.

This formula seems more reasonable than one based principally upon the mechanical operation of the hammer, as in the analysis of the case the hammer is simply the contrivance used to place the pile in position under the ground.

When driving piles, it is assumed that the field engineer will use his judgment to determine, if possible, whether a pile has hit a boulder, whether it is brooming underneath the ground or has split or sheared off where the eyes cannot see. Good judgment in this respect comes only from actual experience. To apply too many mathematical formulas to pile driving is in the nature of a subterfuge. CHARLES F. ROHDE.

Brooklyn, N. Y., Feb. 26, 1916.

Engineers Discuss Complaint of One of the Bidders

Sir—Lo, the poor engineer! He is tried and found guilty of making his estimates too high and of making them too low. He is a rascal in the first case and a criminal in the second. He is found guilty by his contractor friends, who object to making their own estimates, and is sentenced to "a punishment fitting his crime" by so eminent an authority as *Engineering News*—and all that without any representation at court.

I grant you that there are incompetents and even selfishly dishonest men calling themselves engineers, but let us give them a fair trial before we condemn them.

Have you ever, as an engineer, made a reasonable estimate and had a contractor refuse to bid because it was too low? I have. Have you then made other similar estimates and had the same contractor bid so much below you that your estimate looked foolish? I have. Did he then tell you he had to do it to meet threatened competition from another contractor? He told me that.

Did you ever make an unusually high estimate on a certain class of work on account of unusually difficult conditions and insert in your specifications that "bidders must assume responsibility for their bid by personal inspection of the ground" and then have some contractor make a foolishly low bid even for normal conditions? A friend did. Were you then charged in the District Court with making a criminally fraudulent high estimate to protect your contractor friends? My friend was.

Are you limited by law in the amount you can spend on an improvement by the amount of your preliminary estimate? Most of us are. Are the conditions such that you can tell within close limits what the actual costs will be? They generally are, but not always.

Are these not all pertinent questions, and do they not make our work difficult enough without the acceptance of such biased estimates as presented by "One of the Bidders"?

I do not know anything about the contract on which he bid, except as he describes it; but let us analyze his estimate on his own statement of conditions:

First, "cement costs $1.50 per bbl., with the usual 10c. per bag refund"; but it takes four sacks to hold a barrel, so the net cost of cement is $1.10 instead of $1.40. Then with 10c. added for cartage and storage and testing, the cost is $1.20 instead of $1.50, and the cost per cubic yard is $1.80 instead of $2.25.

Second, "gravel and sand were offered at 90c. per cu. yd." If the gravel contained nothing smaller than ½ in., we could not put more than 1¼ yd. of combined material in a yard of 1:2:4 concrete. Gravel grading down to ¼ in. would require even less per yard of concrete.

As to 20% loss, why should there be over 5% in a well-managed organization? The contractor would surely require from the dealer that the sand and gravel be clean enough to pass the specifications, so the loss from condemned material would fall on the dealer. A total allowance of 1.3 cu.yd. of sand and gravel should be fair. This amounts to $1.17 instead of $1.62.

The present quotation of steel at the mill for ½-in. bars is $2.05. Freight is probably in the neighborhood of $2, and the bending, placing and wiring of steel in the class of work described should be done for $8 per ton. This amounts to $2.55 per 100 lb., or $3.32 per cu.yd. of concrete instead of $3.90.

The retaining walls probably contain about 60% of the concrete above the footing, or 16 cu.ft. to the cubic yard of total concrete. Then if 27 sq.ft. of forms is required to the cubic yard, the average thickness of the wall is 16 ÷ 13.5, or about 14 in. Does it really cost "One

of the Bidders" 10c. per square foot to build that class of forms? I have actually worked for a contractor who did it for 6c. I will admit there might be unusual features unknown to me, which make the work more expensive. I am assuming work of average difficulty, so let us figure it at 8c. and find $2.16 per sq.yd. instead of $2.70.

Mixing and placing and water and waterproofing could cost $1 per yd. under difficult conditions. Overhead expense is a fair item as estimated. We have then for our estimate:

1.5 bbl. of cement at $1.20	$1.80
1.3 cu.yd. sand and gravel at 90c.	1.17
130 lb. reinforcing steel at $2.55	3.32
Mixing and placing	1.00
Forms	2.16
Overhead	.50
Total	$9.95
Profit, 15%	1.50
	$11.45
Royalty, 10%	1.28
Total estimate	$12.73

True, this is considerably more than $7.65 per cu.yd., but it also is 14% less than "One of the Bidders" estimated, without changing the profit in any way except to increase the per cent. in that item; and it is fairer to both parties than either $7.65 or $14.92.

We all agree that the engineer's estimate should be fair and allow for a reasonable profit. "One of the Bidders" made his estimate much as an old, experienced contractor told me that he did. He said he was like the old backwoodsman who always first aimed squarely at the squirrel sitting on a limb and then allowed a little for crawl. But if an engineer "allows a little for crawl," it is almost a certainty that some bidder anxious for work, or even more anxious to keep competition shut out of the territory, will underbid his estimate so far that he is placed in the class of those who make their "estimate absurdly high in order to enhance their own reputations."

What is the fair course, then, to pursue? Is it not, as you suggest, that the engineer make a fair estimate; and if he is not familiar enough with all the details to do so, should he not ask that competent consulting advice be furnished him?

But how can the engineer protect his reputation, even by this course, from the erratic bidding of the many who "start in the direction of the well-populated graveyard of their profession" by "filing bids without attempting to make even a rough estimate of the cost," to say nothing of the pernicious combination of bidders to hold prices too high or the absurdly low bid to shut out dangerous competition? AN ENGINEER.

Kansas, Feb. 8, 1916.

Sir—In your issue of Feb. 3 you published a letter under the heading, "Contractors Should Not Rely on Engineers' Estimates," wherein "One of the Bidders" complained of the injustice done contractors by the inaccurate advance estimates of cost prepared by engineers.

While the engineering profession will, I am sure, agree with your editorial comment that the engineer's estimate should be approximately accurate and include a margin of profit for the contractor, the fact remains that there is likely to be nearly as much variation in engineers' estimates as in those of contractors. As the engineer's estimate is not usually prepared for the convenience or guidance of the prospective bidders, the contractor who submits a bid prepared by the "shaving" process deserves what he gets.

I must, however, take exception to the statement that "his estimate, which he offers, seems to be fair" and, without going into details, beg to call your attenion to several discrepancies in the figures given.

The correspondent states, "The cost of standard cement f.o.b. cars was $1.50 per bbl., with the usual 10c. per bag refund." Yet in making up his estimate he used $1.40 as the net price for a barrel of cement, either with the idea that only 25% of the bags would be returned or unintentionally having confused the units employed.

He also says: "The walls had to be waterproofed on both sides . . . Approximately ½ sq.ft. of waterproofing was required per cubic foot of concrete," or 13½ sq.ft. per cu.yd. Assuming this to be the area of both faces of the wall per cubic yard of concrete, it is not made clear why 1 sq.ft. of forms for each cubic foot of concrete is required, or 27 sq.ft. per cu.yd., which is twice the area given above. Without details it is impossible to verify either of these figures; but if the first is correct, the cost for forms would be $1.35 lower than that given.

I make no attempt to justify the engineer's estimate of $7.65 per cu.yd.; but unless my deductions are very much in error, your correspondent's estimate could be cut $12,000 without reducing the item of "Profit"—and probably some more.

Anyone who has studied bid tabulations on miscellaneous jobs during the last few years will have noticed many in which the highest bid was from 50% to 100% above the lowest bid, with the engineer's estimate frequently somewhere in between. I know of one instance where 12 bids were received ranging from $45,391 to $92,496, the engineer's preliminary estimate being $59,674. It may have been a coincidence that one of the bids was $59,654.

Personally, I incline to the belief that the tendency of engineers estimating on public work is to over-estimate rather than under-estimate and that frequently "Profit" is included in every item and then added as a percentage of the whole.

It is probably true, however, that even with the best of intentions, engineers will sometimes fail to include certain elements of cost, the omission of which may mean the difference between profit and loss to the successful bidder. LEICESTER DURHAM.

Municipal Building, New York City, Feb. 14, 1916.

[The preceding two rebuttals of the letter entitled "Contractors Should Not Rely on Engineers' Estimates" were submitted for reply to the writer of the letter. His comment follows.—Editor.]

Sir—In my first letter the cost of cement should read $1.80 per bbl. with the usual 10c. per bag refund, instead of $1.50 as printed. The work was strung out along a line nearly a mile long, partly on the river bank, partly on a dirt street and the rest of the way through a garbage dump.

The location, together with the specifications that the *minutest* particle of foreign matter in either the sand or the gravel would cause its rejection, accounts for the heavy allowance for waste of these items. Some of the walls were 33 ft. high, and of necessity a section must be completed before another one could be started, which required well built and strongly braced forms.

The plans gave only approximate elevations for the base of the wall and no assurance was given that the steps

in the foundation would be in any fixed amount, the height and frequency of the steps would be determined as the excavation proceeded. The wall showed a coping on both face and back, precluding the projection of any forms above the wall. The location of the work is subject to overflow of the river. Only that part of the wall that showed above the ground was to be waterproofed. The work was to be started at once and pushed with vigor, which precluded waiting on mill deliveries of steel.

The courts have held that the engineer is the engineer for the contractor as well as the engineer for the contractee. If this is the case, can we not by the same process of reasoning make the engineer the engineer for the *bidders* as well? "ONE OF THE BIDDERS."

Military Fitness of New York State's Engineers

Sir—Referring to the letter signed "Vet," in your issue of Feb. 24, 1916, in regard to the military training of the engineers in the employ of New York State, I wish to say that in the Highway Department alone there are fully 800 employees, and they do very little office work, except for a short time in the winter. They work ten hours in the field and often longer, and they do all their traveling on foot, carrying their instruments. They are a hardy, rugged lot of engineers, made up of men with all sorts of experience in railroad and heavy construction work. The engineers from the state engineer's department are also used to hard work and long hours, except those that have always been in the office, of whom there are comparatively few. In this department you will also find men with a variety of experience.

I cannot see where you can find a better set of engineers for military duty than those employed by the State of New York, and the majority of them are willing to serve—but not as the proposition was put to them by the governor. His plan would make them lose their salary and vacation time, as well as pay their own expenses while training. In the Highway Department most of the men have families and cannot afford to lose any time, as a large number of them are laid off for a month during the winter through lack of work.

Hudson, N. Y., Feb. 25, 1916. O. HASBROUCK.

Sir—I was much interested in reading a letter in *Engineering News*, Feb. 24, by so-called "Vet," concerning the making of military engineers out of the engineers in the employ of New York State. The statements contained therein are far from the truth, and therefore, in justice to the many able and faithful engineers in the employ of New York State, I have considered it unwise to let the letter pass unchallenged.

In the first place, I have grave doubts whether the one who signs himself "Vet" has an intimate acquaintance with a very large proportion of the 1,200 engineers in the state employ. If he has such acquaintance, his ability to judge human nature, especially as found in engineers, is admitted only by himself. He says that a large proportion of the engineers in the state employ have never done any work independently. A great deal of evidence would be necessary to establish this contention. I will say that such a broad statement is not in the light of reason nor founded on facts. The actual value of construction work supervised by the state's engineers has long since passed the $100,000,000 mark. Consequently, the statement that they have always worked inside an office is simply absurd.

As for the test of driving a nail through a block, whether the block would be split in the operation would depend upon the size of the nail as well as upon that of the block.

A day when men in the various construction parties on the state canals and highways do not walk more than ten miles over rough land is most uncommon. Whether or not the New York State engineers know the exact weight of a rod of barbed wire is immaterial to the discussion of so broad a subject as their fitness for military service. A great deal would depend upon the extent of the barbed-wire entanglement to be placed, as well as upon the number of men included in a handful, to decide whether an equivalent number of men of "Vet's" type could do the work faster.

The New York State engineers will be ready when their services are required. All those whom I have been in contact with have appreciated Governor Whitman's motive and have filed their applications for the purpose of entering the training camps under the instruction of United States Army officers. A. E. STEERE.

Mark Building, Amsterdam, N. Y., Feb. 25, 1916.

Some Faults of Our Patent Laws

Sir—Your article on Bone's retaining-wall patent and your further remarks on reinforced-concrete patents, in your issue of Feb. 10, open up important matters for discussion. The following quotation is especially pertinent:

> In many patents the engineering evidence of use prior to the patent application is overwhelming, though there is much difficulty in impressing such evidence on the intelligence of the court.

If such evidence is overwhelming, why was it not considered by the Patent Office? The answer is simply this: The entire appropriation for investigation of prior public use made by the United States Congress amounts to the paltry sum of $150 per year for all patents and all arts. Likewise, the appropriation for proper filing systems of technical literature and facts bearing upon the allowance of claims is equally insufficient. The result is obviously this: Patents are issued embodying claims based upon an insufficient consideration of the prior art and such that, if the art, as subsequently indexed and tabulated by the industrious examiners of the Patent Office at a later date, were to be considered, these claims would be held invalid.

Under these circumstances why should there not be a provision similar to that of Canadian law for the annulment of patents erroneously issued? This would prevent the levying of legalized blackmail on the public at large upon the basis of mere paper patents.

The difficulty you mention of impressing engineering evidence on the intelligence of the court is illustrated in a recent decision in which the judge held that a patent on reinforced concrete to be valid must cover the process of burying metal in concrete—a process older than the Christian era. In another case the judge asked whether a patentee who applied for a patent in 1901 was the first ever to have embedded metal in concrete.

It is frequently said that the majority of judicial decisions in the field of structural engineering are rendered contrary to, rather than in accord with, the fundamental

laws of physics and mechanics. This is because of the mischievous success of patent attorneys whose highest ambition is to mislead the court by plausible misrepresentation of these principles. Many users are coerced into paying tribute upon an inoperative patent, because of the expense of a contest and the general feeling that in trying a case before a tribunal of judges innocent alike of any knowledge of the principles of mechanics and the history of the prior art the claims in a technically worthless patent have just as much chance to be upheld broadly as the claims upon a useful improvement.

In this country, unlike Canada, there is no legal machinery available to curtail the fraudulent claims of swindlers and speculators in the patent field. The judicial outcome of a patent case, after rendering a decision in the absence of a complete exposition of the prior art, permits a kind of legalized blackmail not tolerated in countries more advanced in the scientific administration of justice than our own. Is it not time that some effort was made toward improving this condition? Would it not be a distinct advance for the court to requisition from the Patent Office the latest complete prior-art records and the primary examiner's review thereof, so that the deficiency due to lack of proper appropriations in the past may be remedied?

C. R. SPEERS.

Des Moines, Iowa, Feb. 22, 1916.

Initial Stress in Rivets

Sir—Mr. Friedland's article on rivet tension, in your issue of Feb. 17, contributes a most ingenious analysis to the literature of riveted joints. This analysis is based upon the assumption that we have elastic action in the shank of the rivet. I should expect, in view of the hundreds of degrees of cooling of the rivet after driving, to find the shank in tension up to the elastic limit. Any increase of this tension would cause stretch in the shank and a consequent relief of the initial tension. It seems probable that the rivet shank could endure a permanent deformation that would make the initial shank tension zero and leave as stress in the shank only the load pull on the head.

It is certainly conservative to say that rivet shanks "often have an initial stress above what would be permitted in safe steel design," but the conclusion therefrom that tension rivets are to be avoided is unwarranted.

Lafayette, Ind., Feb. 19, 1916. ALBERT SMITH.

A Tip to Manufacturers

Sir—A great amount of money is spent each year by manufacturers and sales corporations for trade-paper advertising, house organs, catalogs and other sales literature that does very little of the work for which it is designed. A large percentage of such unavailing literature finds its way to the waste basket at once, while some that on casual observance seems good enough to keep is consigned to the same place the first time the recipient chances to use it as a source of information on the subject to which it pertains. This is true to some extent (although not as much so as in the past) of literature on materials, both "finished" and "raw," entering into the construction of buildings.

Some catalogs and trade publications give a vast amount of information regarding the product or products in question, so that these articles can be properly and satisfactorily applied; but others speak in flowery-worded phrases of the great number of buildings in which a certain material has been used, of "repeat" orders, etc., all intended to make the prospective purchaser, architect or engineer feel that a special privilege is being granted him as a member of the *élite* in return for his using the material in question. As a general rule the purchaser, architect or engineer does not care so much about the photographs of buildings wherein a certain material or product has been used as he does about general and typical citations serving as a guide to his judgment.

As an actual example of the uselessness of some catalogs, the following experience of the writer is typical of several fruitless searches through such publications for data of a useful character. In designing a machine shop it was found advisable to provide ventilation in the roof by means of circular galvanized-iron or copper ventilators. A search through the various catalogs and trade publications failed to disclose any real, pertinent information on the subject of the proper size of ventilators to be used for different classes of occupancy. Much space was devoted to photographs of successful installations, but not enough information regarding the general conditions to be met was given to allow a designer to gain any idea as to the proper size to be used. This could readily have been done by means of a small cross-section of the building, showing type of construction, height, occupancy, side-wall ventilation, and spacing of circular vents in the roof.

If each manufacturer would do this, a designer would have some basis for comparing the relative merits of the different brands; and satisfied, instead of dissatisfied, customers would be the result in the great majority of cases. A firm with a good product should not be at all backward in citing the facts that the users should have before them in order that an intelligent selection can be made.

Other examples of similar nature could be cited; but in order to make this letter brief, they are omitted. When expending large sums of money for catalogs, it seems like short-sighted economy to save money by omitting such data as require some labor and skill to prepare, but which constitute a vital factor in a successful selling campaign. Too many catalogs are mere picture books that cost a lot of money and say practically nothing regarding the product in question. As a result they are poor business-getters.

C. A. TALOGS.

Chicago, Jan. 27, 1916.

NOTES AND QUERIES

George Herrick Duggan is president of the Canadian Society of Civil Engineers. In the biography published in "Engineering News" of Feb. 17 Mr. Duggan's middle name is incorrectly given as Eric.

Responsibility for Damage to a Transit—An assistant in a city engineer's office was running the center line of a public street, using a transit belonging to the city engineer. There was plenty of room for teams to pass the transit, and several teams had passed where the work was in progress. A buggy carelessly driven came past, however, knocked the transit over and broke it. Inquiry is made as to whether the party causing this damage can be made to pay for the cost of repairing the instrument. Offhand, one would say that it is the duty of the instrument man to guard his instrument, but there may be cases where courts have ruled the contrary.

Arkansas and White River Floods of 1916

By Elliott J. Dent*

In the drainage basin of the Arkansas River above Fort Smith there were two storms during January, 1916, and two distinct rises in the river at Fort Smith. In the lower river the two rises were merged into one. At Fort Smith the peak of the first rise passed on Jan. 23 with a gage height of 26 ft., while the second rise did not begin until Jan. 27. Farther downstream, at Little Rock, the crest of the first rise passed on Jan. 26, and the second rise began on Jan. 28. The net result was a great flood in the lower Arkansas River, although greater floods are of record.

In January, 1916, the crest of the flood from the White River above the mouth of the Black had passed the junction before the crest of the flood from the Black River reached that point.

With the Mississippi at a high stage, as was the case during the period under consideration, the flood heights in the lower Arkansas and lower White River Valleys are materially affected by the backwater from the Mississippi. In the Arkansas River this effect is felt well above Red Fork, and in the White River it reaches above Clarendon.

A discussion of the floods of the lower Arkansas and White River Valleys is somewhat involved, owing to the many factors entering into the case, but for the upper rivers we have the simple relation between rainfall and floods shown by the accompanying table.

RAINFALL AND RIVER STAGES AT FORT SMITH ON THE ARKANSAS RIVER AND CALICO ROCK ON THE WHITE RIVER

	Fort Smith		Calico Rock	
Jan., 1916	Rainfall, In.	Gage Height, Ft.	Rainfall, In.	Gage Height, Ft.
21	0.78	10.2	0.24	5.3
22	0.00	24.8	0.30	6.3
23	0.00	26.0	0.00	7.3
24	0.00	25.5	0.00	8.1
25	0.00	24.0	0.00	7.9
26	2.50	21.6	0.00	6.7
27	0.19	29.0	1.02	8.8
28	0.35	30.0	0.35	22.2
29	1.02	30.6	1.30	32.5
30	1.05	32.7	1.80	36.6
31	T	32.0	0.90	48.5

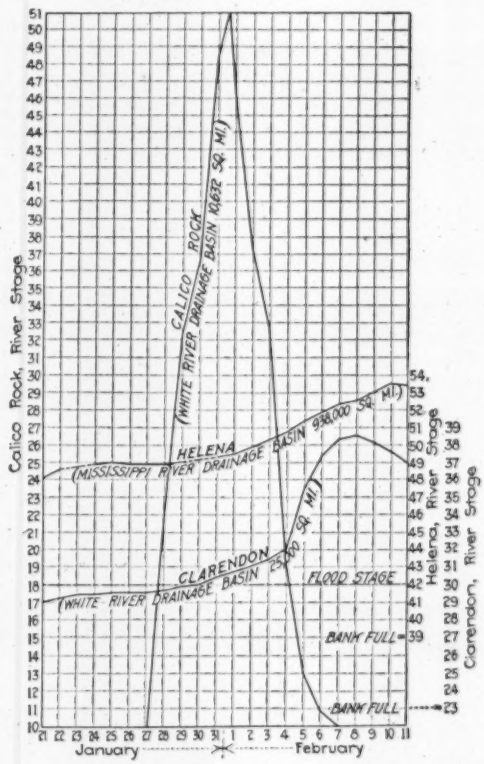
At Calico Rock the highest stage reached was 51 ft. at 9 p.m., Jan. 31, the highest previously recorded stage having been 48.5 ft. In the White River new records have been established throughout the valley below Calico Rock. A diagram showing the river stages at Calico Rock and Clarendon on the White River and at Helena on the Mississippi River is shown herewith.

Along the banks of the Arkansas and White Rivers the levees of the Mississippi River system extend but a short distance upstream from the junction point. Above the ends of these works local improvement districts have in many cases built levees. The latter were in several instances overtopped or broken. Where no levees have been constructed, the damage due to an extra foot or two in the height of the flood above the ordinary flood stage is relatively small. Where levees have been built, however, an extra foot, by overtopping and breaking the levee, may cause the submergence of large areas to considerable depths when no submergence whatsoever has been anticipated.

The City of Newport, on the White River, was guarded by a local levee. When the reports of the magnitude of the flood in the upper river were received, it was at once apparent that the levee would be overtopped and the city flooded. Preparations were promptly made, and everything movable was placed above the flood level. The result was that the loss was reduced to a minimum.

In the City of Clarendon it was, until too late, thought that the local levee would protect the city. The loss there was considerable; but as numerous water craft were available, it was possible to remove a large percentage of the population before the shortage of supplies became acute.

There were no breaks in the levees on the north bank of the Arkansas River, but breaks of considerable magnitude occurred on the state convict farm at Cummins and at other places on the south bank. Water flowing through these crevasses did not return to the Arkansas River, but flowed south across country into the bayous heading near the Arkansas River and emptying into the Ouachita.



RIVER STAGES AT CALICO ROCK AND CLARENDON ON WHITE RIVER AND HELENA ON MISSISSIPPI RIVER

Farms and towns in this locality had long been free from floods. The overflow came suddenly, and people as well as stock were marooned in houses or on small knolls or ridges, in many cases without adequate supplies or shelter. River boats could not go to their rescue, and flat-bottomed rowboats built of material at hand were the only means of transportation. Assistance was promptly rendered by the communities that were not flooded, and the situation was well in hand within four or five days.

The interruption to railroad traffic was considerable, but was principally due to the submergence of tracks. No large bridges were lost, and the washouts were less extensive than had been feared. It is doubtful whether in the Arkansas and White River Valleys there was a

*Major, Corps of Engineers, U. S. A., Little Rock, Ark.

single line 200 mi. or more in length that was not blocked at some time during the high water.

By Feb. 11, nearly all lines were operating, although fast trains were not maintaining their schedules. The principal exceptions were the lines affected by backwater from the Mississippi. The main line of the Cotton Belt system was still interrupted at Clarendon, and the Missouri Pacific line from McGehee north to Helena and Memphis was under as much as 10 ft. of water at the worst point.

As stated in the telegraphic report printed in *Engineering News* of Feb. 10, about 1,500 lin.ft. of revetment was lost at Pine Bluff. A few small dwellings and other structures caved into the river as a result of this failure. The maximum depth of the caving measured perpendicular to bank line was about 150 ft. As the water receded, it became evident that there had been some material changes in the channel at Little Rock, and a considerable expenditure for bank protection on both sides of the river may be necessary in that vicinity.

Lock and dam No. 2, White River, were considerably damaged. The lower lock gates were carried away, and there were several minor washouts in the levees at each end of the dam. The top timbers of the dam were carried away in two places, but the full extent of the damage cannot be determined until a lower stage is reached. Unless the breaks are materially enlarged before the next low-water season, the only interruption to the use of the dam will be the time required to replace the lower gates.

Purchasing Water-Works Plant of Bath, Maine

By Frederic H. Fay*

In the recent acquisition by the City of Bath, Me., of its water-works system formerly owned by a private company two precedents have been established so far as important privately owned plants in the East are concerned. The first is that in the determination of the price to be paid by the city for the works the whole matter was left to two engineers—Frederic H. Fay, of Fay, Spofford & Thorndike, Boston, and William B. Getchell, Augusta, Me.—and they were able to reach an agreement without calling in a third arbitrator. The second precedent is the fixing of an award that is less than the reproduction cost of the plant.

The award of the appraisers in the Bath valuation case is $539,500, which is nearly $20,000 below the reproduction cost agreed to by both parties. Notwithstanding that this award is considered a very favorable figure for the city, the water company is apparently satisfied with the result, especially when it is considered that the expense of costly litigation has been saved, which might easily have cost the two contestants $50,000 apiece. Moreover, a large amount of time, valuable to both parties, but ordinarily taken up in legal proceedings, was saved. From the time when the Water District was incorporated and began preparations for the purchase until the final payment was made, less than four months elapsed.

The Bath Water District was created under Chapter 197 of the Private and Special Laws of Maine of 1915, accepted by vote of the inhabitants of Bath. The date of incorporation of the district was Nov. 1, 1915, when the three trustees who are to administer the affairs of the district took office. Immediately thereafter the trustees engaged Fay, Spofford & Thorndike as consulting engineers to the district. During November and December this firm made an inspection and appraisal of the Maine Water Co.'s plant at Bath, in which work representatives of the company coöperated to the fullest possible extent on facilitating the inspection and furnishing data of the system. In fact, throughout the whole proceedings the relations between the company and the city and the representatives of both have been most friendly and mutually helpful.

During the month of January, 1916, an understanding was reached between the company and the city, by which it was agreed that a part only of the questions at issue—the value of the water rights and the reproduction cost and depreciation of the physical plant—should be referred to the engineers representing the two parties, in the hope that these items might be mutually agreed to and finally disposed of before litigation was begun, the agreement of the engineers upon any or all of these items to be binding upon both parties. Under this arrangement a conference of engineers was begun on Jan. 31. The Maine Water Co. was represented by three engineers—William B. Getchell, Augusta; John H. Burleigh, Waterville; and Walter F. Abbott, Bath (the latter being superintendent of the company's Bath plant)—while negotiations in behalf of the city were conducted by Frederic H. Fay, for the consulting engineers, Fay, Spofford & Thorndike, assisted by E. L. Walker, C. A. Farwell and R. W. Horne, assistant engineers for that firm. In three days' conference these engineers reached an agreement on a reproduction cost as of Jan. 1, 1916—the date of the taking—of all parts of the physical plant as well as the value of the water rights. They failed to agree, however, upon the subject of the depreciation of the physical plant.

At the conclusion of this first conference the novel suggestion was made by the counsel of the water district to the president of the company that the entire matter of the determination of the purchase price be left to two arbitrators—Mr. Getchell and Mr. Fay—with the proviso that in case these two engineers failed to come to an agreement they should select a third arbitrator, not an engineer, the decision of these arbitrators to be final and binding upon both parties. Messrs. Fay and Getchell met in conference on Feb. 10, 1916. Through their knowledge of the principles governing engineering values and their intimate acquaintance with the facts of this particular case, and without even the necessity of calling in a third arbitrator, they reached an agreement that day and made their award of $539,500 as the purchase price for the entire water-works.

There are two distinct methods of conducting negotiations of this nature—one, the method of contention and litigation, in which the interests of the parties are regarded as diametrically opposed; the other, the method of confidence and coöperation, in which the community of interests of the parties is given full recognition. In the minds of many people, especially in the past, the first method has been regarded as the only one possible. The purchase of the Bath water-works furnishes an excellent instance of the uptodate efficiency of the latter method and of its practical applicability as a saver of money, time and other valuable assets.

*Of Fay, Spofford & Thorndike, Consulting Engineers, Boston, Mass.

News of the Engineering World

Road Builders Association Meets at Pittsburgh

The American Road Builders Association held its thirteenth convention at Pittsburgh last week, with a total registered attendance of about 2,000. An exhibit of road machinery and materials was arranged in the old exposition building, with some 80 exhibitors. The recently elected president of the association, Col. E. A. Stevens, State Highway Commissioner of New Jersey, presided at the sessions. The States of New Jersey, Pennsylvania and Ohio were especially well represented in the attendance.

The sessions held on Monday evening and Tuesday morning were devoted to the popular side of good road work, addresses being made by Governor Major and Congressman Shackleford, of Missouri, the latter the author of the Federal aid bill that has passed the House and is now before the Senate; also by Hon. Philander C. Knox, ex-Secretary of State, the Mayor of Pittsburgh and other public officials.

In the technical sessions a paper by R. Keith Compton, chairman of the Baltimore Paving Commission, urged that cities should have legal authority to prescribe the type of construction to be adopted for street-railway tracks laid in paved city streets. This has been done in Baltimore; and on heavy-traffic streets the railways are required to lay ties on a concrete platform. The space between the ties is afterward filled in with concrete up to the level of the under side of the paving blocks. These latter are laid on a bed of cement and sand and not on sand alone.

In order to lay this track without interrupting traffic while the concrete is setting, the track is laid on a bed of broken stone under the ties. It is then poured full of cement grout of the consistency of thin cream; and it sets satisfactorily, notwithstanding the continual passage of cars over it while it is setting.

Several electric-railway engineers present sharply criticized the Baltimore requirement, arguing that the rigid concrete bed was too hard and had proved unsatisfactory, as had the earlier attempts to lay the rails directly on concrete beams. They preferred to lay the ties on broken stone, which could be tamped when necessary to keep the track in surface.

George E. Datesman, Director of Public Works of Philadelphia, read a paper describing the control of street openings in pavements in that city. He claimed that Philadelphia had a more complete system of records of its underground piping than any other great city of America and described in detail the methods of control and record.

H. W. Durham, late chief engineer of street paving of the Borough of Manhattan, referred to the claim often made that European city streets are not torn up for pipe connections as are American streets and said that his own investigations in foreign cities proved that street openings in pavements are as numerous there as here.

W. D. Uhler, Chief Engineer of the Pennsylvania State Highway Department, described the new concrete road between Easton and Allentown, now under construction, of which about 3½ mi. was completed last fall. Tests made to determine how long a time the concrete should be mixed in a batch mixer show that the time should be from 1½ to 2 min. Test cubes of concrete mixed 3, 4 and 5 min. did not show materially greater strength. Transverse joints are spaced 35 to 40 ft. apart, and metal joint plates have been used on only 1,000 ft. Reinforcement is used and is delivered in flat sheets instead of in rolls. It is placed 2 in. below the top of the slab. So far only two small cracks have showed up in the entire 3½ mi. The concrete is 6 in. thick at the sides and 8 in. at the crown, with a 1 to 2 to 3 mix, and is costing $1.20 to $1.25 per square yard.

The brisk discussion of Mr. Uhler's paper evidenced the great interest in concrete-road construction at the present time and brought out some notable examples of concrete paving that has been down for many years and is still in excellent condition.

The gravel roads built by the State of New Hampshire were described by F. E. Everett, State Highway Commissioner. These roads, built at an average cost of less than $3,000 per mile, have greatly pleased the summer-tourist traffic, which they chiefly serve. They were described in *Engineering News*, Dec. 9, 1915, p. 1110.

"Brick Streets and Roads" was the subject of a paper by H. E. Breed, Deputy Highway Commissioner of New York. After describing the present standard practice in brick-road construction in New York, he said that the state has now 290 mi. of brick roads, which have cost on the average $2.01 per square yard. The average maintenance cost of these roads last year was $176 per mile, but this included some extensive repairs on some 10-yr. old roads that had not been properly built and maintained. Excluding this work, the cost of maintenance was only $131 per mile, which included work on ditches, drainage, railings, etc., apart from the road surface.

That stone-block paving practice is tending toward the use of shallower blocks, only 3 to 4 in. deep, was the contention of Charles F. Knowlton, of Boston, in a paper on "Recent Tendencies in Granite Paving." This statement was denied by H. W. Durham, who pointed out that the increase in labor costs in laying small blocks tends to offset other saving. Others claimed that a deeper block is needed to give sufficient bonding surface for the joint material.

R. B. Sage, Chemist of the New Jersey Road Department, discussing the function of stone in a bituminous-concrete pavement, urged that the stone chosen should have low absorptive power. Otherwise, water soaks through the stone to the asphalt matrix in which it is held, and the stone is thereby loosened. He also urged the use of large stone in the mixture to reduce voids.

Other papers read were by Joseph W. Hunter, on "Road Foundations"; Henry L. Bowlby, on "The Columbia

Highway"; and Charles N. Upham, on "The Du Pont Road."

The Committee on Resolutions made a report at a business session on Thursday afternoon, and the following were adopted:

Resolved, That this association invites the attention of State, county and municipal authorities to the value of traffic censuses as a means of determining the relative values of various forms of pavement and road construction and would strongly recommend that systematic traffic censuses be taken from time to time on all classes of roads and pavements in order that more definite knowledge of the economic value of the different types of construction may be obtained. In taking such censuses separate counts should be made of horse-drawn vehicles, light and heavy, and of motor vehicles, classified as pleasure and commercial cars, with notes as to the use of especially heavy trucks and vehicles with tires especially injurious to roads. Where it can be used, in order to obtain comparable information, the standard form for taking traffic censuses reported by a committee of the American Society of Civil Engineers is recommended.

Resolved, That where funds for road construction are raised by an issue of bonds, this association urges that the serial form of bond, by which a part of the principal is paid off each year, be adopted in preference to bond issues to be paid by accumulations in a sinking fund.

Resolved, That this association urges that laws be passed and enforced in each state establishing reasonable limits for the weight, dimensions and speed of heavy motor vehicles.

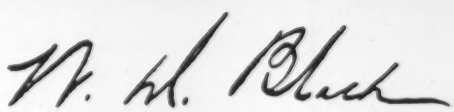
Col. William M. Black To Be Chief of Engineers

Col. William M. Black, New York City, has been appointed Chief of Engineers to succeed Gen. Dan C. Kingman, who retired from office on Mar. 6, having reached the age limit. Colonel Black is one of the best-known officers in the Corps of Engineers. He was born at Lancaster, Penn., Dec. 8, 1855, and can serve as Chief of Engineers, therefore, for nearly four years before reaching the age limit.

Colonel Black received his early education at the old Franklin and Marshall College in Pennsylvania and graduated from West Point in the class of 1877. During his long time of service he has had an unusual amount of experience in municipal engineering work. He was an assistant to the late Col. William L. Ludlow in the early 80's, when the colonel "cleaned up" the Philadelphia Water Department. In 1897 and 1898 he was Engineer-Commissioner of the District of Columbia, and he rendered important service again under General Ludlow in the sanitary regeneration of Cuba and its cities after the Spanish-American War.

During the past seven years Colonel Black has been in charge of the United States Engineer Office in New York City, where many important municipal problems have come before him, such as the investigation in connection with the pollution of New York harbor by sewage discharges.

Colonel Black rendered important service during the Spanish War, being successively Chief Engineer of the Third Army Corps, Chief Engineer of the Fifth Army Corps and on the staff of the Major General in Command during the last half of 1898. He served at Tampa, Fla., and organized a battalion of engineers for the Porto Rico expedition and bought and had charge of all the engineering material used. He was in command of the first landing party of United States troops at Guanica, Porto Rico, July 25, 1898. Colonel Black was the first United States engineer officer to take charge in Panama when the United States took over the Isthmian Canal work.



Colonel Black has been for some time the senior member of the Board of Engineers for Rivers and Harbors and also Department Engineer of the Eastern Department.

One of the most notable engineering works with which Colonel Black's name is connected was the removal of the wreck of the battleship "Maine" in Havana harbor. He was a member of the Board of Engineers in charge of this work and gave to it his personal supervision.

Denver Water-Works Struggle

Promise of settlement of the long struggle between the City of Denver and the Denver Union Water Co. is afforded by an option contract for the purchase of the works by the city, entered into between the Public Utilities Commission of the city and the Denver Union Water Co. on Feb. 21. The agreement has also been approved and adopted by the Denver City Council and by the stockholders of the Denver Union Water Co.

Under the option contract both parties accept $13,416,000 as the value of the entire holdings of the company used to supply water to Denver. This valuation is as of May 1, 1914, and is subject to a depreciation charge of $140,000 per annum on the one hand and to the cost of betterments since May 1, 1914, on the other. The

basic sum named is the valuation placed upon the plant by W. J. Chinn, special master, appointed by the Federal District Court in a suit brought by the company to prevent a 20% city-ordinance reduction in the rates charged by the company. This valuation was fixed by Mr. Chinn some months ago (see *Engineering News*, Oct. 21, 1915, p. 814) and was confirmed by the Federal District Court on Jan. 28, 1916. In accordance with the option agreement the case is to be appealed to the Supreme Court of the United States. Each side will exert every possible effort to end the suit upon its merits. The option contract holds good until twelve months after the United States Supreme Court shall have disposed of the case. No betterments are to be made to the plant after Feb. 21, 1916, without the approval of the Public Utilities Commission. When the transfer is effected, the price of the works as finally determined by adjudication is to be met in 4½% bonds or in cash, at the option of the city. The city agrees that during the life of the option it will refrain from constructing a duplicate plant, but it is free to complete its surveys now in progress for new work.

There has been almost constant water-works turmoil at Denver for at least a quarter of a century. In 1891 the Citizens Water Co. built works that paralleled the mains of the Denver City Water Co. A bitter rate war ensued. The two companies were consolidated in 1894 as the Denver Union Water Co. Since then there has been much litigation between the company and the city. In 1909 a valuation of $14,400,000 was placed upon the property of the Denver Union Water Co. by a commission of engineers consisting of M. L. Holman, John R. Freeman, C. L. Harrison, Allen Hazen and Frederic P. Stearns, the latter agreeing to the valuation except as regards the item for water-rights.

In 1910 a Public Utilities Commission was created by popular vote, primarily for the task of establishing municipal ownership of water-works. The commission was instructed to offer the Denver Union Water Co. $7,000,000 for its plant. It was also empowered to build works. The company refused the offer and brought suit to prevent the city from going on with construction. In 1913 the United States Supreme Court decided this suit in favor of the city. In January, 1914, a committee appointed by the Public Utilities Commission valued the property of the company at $10,045,000. The valuation dealt with the physical plant only, except for an allowance of $375,000 for development expenses. Other elements of the property were not taken into consideration in view of points of legal conflict.

A. Lincoln Fellows, of the Field, Fellows & Hinderlider Engineering Co., is president of the Public Utilities Commission and was also a member of the committee that placed on the plant the valuation just mentioned.

Regulating Engineering in the State of Pennsylvania

The Commission of Engineers, which has for nearly three years been investigating the question whether engineering practice in Pennsylvania should be regulated by law, has presented a report to the governor, which was made public on Mar. 2. The commission does not recommend legislation requiring all engineers to pass examinations and be registered in order to practice their profession. It does recommend that there should be regulation by law of the practice of engineering in the s[illegible] and municipal service. The plan it has worked out is, in brief, that engineers in subordinate positions should be required to pass civil-service examinations. Engineers above a certain rank should be selected on their professional record without examination; and consulting engineers and experts for temporary engagements should be required to file with a state board a sworn statement of their professional record. The final conclusions of the commission are as follows:

1. It is desirable in general, for the better protection of the life, health and property of the citizens of this Commonwealth of Pennsylvania, that the employment, retention and discharge of engineers, surveyors and technical men in public service, where competency may be readily determined by examination, should be subject to state or municipal civil-service regulation.

2. In cities of the first and second class in Pennsylvania such civil-service examinations may properly be conducted, as at present, under independent local management; but consulting engineers and experts for special temporary engagements should be exempt from examination.

3. The above class of engineers and experts should be required to register with a state board before being permitted to practice. They should file a sworn statement of their professional record and confirmatory statements from others, if called for, and unless promptly disapproved, this filing should be sufficient precedent to practice. The board should have power, for adequate cause, after hearing, to cancel the registration. Also to issue certificates to such experts, if desirable.

4. In the other cities (except cities of the first and second classes) and in the counties, boroughs, townships and municipalities of Pennsylvania and for state work, it is desirable that such civil-service examinations, mentioned in paragraph 1, be conducted by a state department, board or commission in order that these examinations may be governed by reasonable and consistent standards and that a single body may be charged with the enforcement of such standards.

5. Engineers, surveyors and technical employees of the state, counties and municipalities, other than first- and second-class cities, excepting those in administrative positions, should be required to qualify before the said department, board or commission by methods discretionary with the said board. The determinations of standards and classifications should likewise be in the hands of the board; but appointments to engineering or technical positions above a certain rank should not be governed by competitive civil-service examinations. These appointees should be chosen on the basis of their professional record.

6. It is desirable that such appointments to positions of high rank should be made at the initiative of and by the state or municipal department or officer seeking to have the position filled; but with the approval of the State Civil Service Examination Board.

7. This employment will be governed by the same principles as under private corporate management. All those who have passed such examinations should be given certificates of fitness for such work as they can do.

8. Other engineers in practice, who may desire, should have the right to be examined and secure a certificate of fitness and competency in their particular line or specialty.

9. The exemption of public-service companies from the provisions of civil-service regulation at this time is suggested with the thought in mind that a beginning having been made with public works, erected, operated and maintained by the state and municipal governments, prudence dictates a reasonable period of time in which to observe the working out of the system before any extension of the system be considered.

10. Plans and specifications for public works built or to be built, operated and maintained by public-service companies and municipalities, should, under the provisions of existing laws, be handled in the proper and respective departments of the state government.

11. It is desirable that the State Civil Service Examination Department, Board or Commission should be authorized to investigate charges of incompetency or official dereliction on the part of engineers or technical men appointed through civil service (excepting cities of the first and second classes) and that it alone should be empowered to disqualify such public servants, and only for adequate cause.

12. It is further desirable that the said State Civil Service Examination Board should act in an advisory capacity in connection with the employment of consulting engineers or experts for special temporary engagements and that no such engagements should be legal if made against its disapproval.

It is the prescribed duty of the Engineers' Commission "to recommend to the governor such measures as, in their judgment, should be enacted into laws." It was the evident intent of the General Assembly that the commission should not be limited by narrow bounds when it came to presenting recommendations to the governor.

There is now an Economy and Efficiency Commission of the Commonwealth of Pennsylvania investigating the duties of every person in the employ of the state, to ascertain what changes, if any, may be necessary to secure greater uniformity, economy and efficiency in the work of the various departments, commissions, bureaus, boards of trustees and other persons in charge of institutions owned or controlled by the state and in the methods of disbursing and accounting for state funds. It is among the possibilities that this Economy and Efficiency Commission may work out the details of a former suggestion that the scope and the duties of the Board of Commissioners of Public Grounds and Buildings shall be extended to really comprise a State Board of Public Works. This department now provides the quarters and furnishes supplies to the several state departments. It inspects the erection of state buildings, of county bridges over navigable streams and has charge of the Capitol grounds and buildings.

If this department were to be reorganized into a Board of Public Works with several bureaus, one of which would do all the architectural work for state buildings, another all construction engineering work on state buildings and institutions, another do all the purchasing of supplies for each and every state department and institution, another have overseeing charge of all state ground and property, etc., etc., it might be very pertinent to inquire into the economy and practicability of adding to the department a bureau of State Civil Service Examinations. The economy would be in the supervision of the work by the Board of Public Works in joint occupancy of office space and fittings and furniture and in the routine maintenance of the bureau.

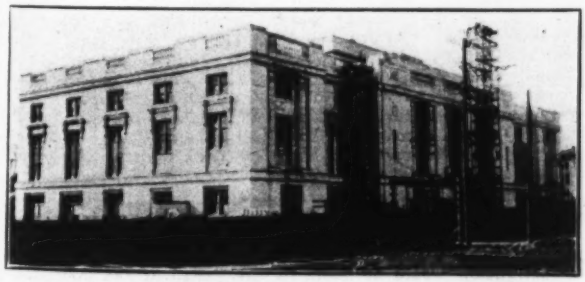
Somewhere in the scheme of state government there should be a Civil Service Examination Department, Board or Commission. The Examining Board should be composed of engineers having the qualifications demanded of the highest-grade membership in the national engineering societies. The members of this Examining Board might be drawn from the staff of the several state departments and from among professional engineers generally. The latter should be fully compensated for their services.

With these suggestions the Engineers' Commission recommends for your consideration the enactment into laws of the measures embraced in paragraphs 1 to 12 inclusive.

F. HERBERT SNOW, Chairman; JOHN PRICE JACKSON, Secretary; SAMUEL A. TAYLOR, G. H. WEBSTER, J. MURRAY AFRICA.

Dallas Union Station To Open May 1

The Dallas, Tex., union railway station, described in detail in *Engineering News*, June 25, 1914, is nearing completion. The accompanying view was taken Feb. 12. It is stated that the station will be ready for use by



THE DALLAS (TEX.) UNION DEPOT AS IT APPEARS TODAY

May 1. The total cost of the improvement will be about $5,000,000. The station will serve seven railways—the Gulf, Colorado & Santa Fe; the Chicago, Rock Island & Pacific; the St. Louis & San Francisco; the Missouri, Kansas & Texas; the Texas & Pacific; the Houston & Texas Central, and the St. Louis Southwestern Ry. lines. This is not a terminal station, the tracks running through.

The chief engineer of the Dallas & Terminal Railway Union Depot Co. is C. H. Dana. The general contractor is C. W. Thompson, Chicago, and the local subcontractor, the Hughes & O'Rourke Construction Co.

Dayton Flood-Protection Plans Ready for Adoption

Five immense reservoirs designed to afford protection against floods 40% greater than the Dayton flood of 1913 and river-channel improvements in nine cities—all at an estimated cost of $23,539,872—are the outstanding features of the plans filed at Dayton, Ohio, on Feb. 29 by Arthur E. Morgan, chief engineer of the Miami Conservancy District. The plans will be open to public inspection for over a month, after which it is expected

TABLE 1. DIMENSIONS AND CAPACITIES OF MIAMI CONSERVANCY DISTRICT RETARDING DAMS AND RESERVOIRS

	Germantown	Englewood	Lockington	Taylorsville	Huffman
Average elevation bed of river	723	768	876	659	777
Average elevation valley floor	730	784	885	770	785
Elevation of spillway crest	815	876	938	818	835
Elevation of top of dam	830	892.5	954	837	850
Maximum elevation of water surface for a flood like 1913.	805	862	936	815	830
Area submerged in a flood like 1913, acres	2,950	6,350	3,600	9,650	7,300
Maximum amount of water stored in a flood like 1913, acre-ft.	73,000	209,000	63,000	152,000	124,000
Maximum average depth of water in reservoir in a flood like 1913, ft.	24.8	32.9	17.4	15.7	17.1
Length of crest of dam, ft.	1,210	4,960	*6,400	*2,980	*3,340
Thickness of dam at average elevation of valley floor, ft.	650	740	410	390	380
Length of outlet conduit, ft.	520	725	45	40	40
Number of conduits	2	2	2	4	3
Total sectional area of outlet conduits, sq.ft.	182	214	158	1,116	705
Maximum discharge of conduits in 1913 flood, sec.-ft.	9,340	11,000	8,630	51,300	32,600
Length of spillway crest, ft.	55	100	72	132	100
Vertical diameter of conduits, ft.	12.3	13.5	10.0	20.5	17.6
Yardage of earth in dams	865,000	4,000,000	1,135,000	1,235,000	1,655,000
Yardage of concrete in dams and appurtenances	20,000	38,000	38,000	47,000	40,000

* Including spillway crest.

TABLE 2. ESTIMATED COST OF MIAMI CONSERVANCY DISTRICT PROJECT

Retarding Basins:	
Germantown	$640,235
Englewood	1,959,632
Lockington	865,218
Taylorsville	1,508,674
Huffman	1,299,125
	$6,272,884
Local Flood Protection:	
Piqua	$128,801
Troy	1,383,619
Dayton	1,383,619
West Carrollton	22,416
Miamisburg	167,267
Chautauqua	4,283
Franklin	115,076
Middletown	81,305
Hamilton	1,274,962
	$3,335,303
Construction of works included in the plan	$9,608,187
Public-service relocations and damages	2,309,315
Real-estate purchases and easements	5,664,200
Administration and general expense	1,758,170
Taxes and special assessments on lands	200,000
Total	$19,539,872
Contingencies	4,000,000
Grand total	$23,539,872

that they will be officially adopted by the directors of the district.

The five dams would be built on the Miami, Mad and Stillwater Rivers and on Twin and Loraine Creeks. Their function is thus described in the engineer's report:

Each dam will have permanent openings through its base through which the ordinary flow of the river and the flow during ordinary freshets will pass unimpeded. During large floods the water which cannot pass through the outlet conduits will be held back temporarily in the basins above the dams.

The conduits are proportioned so that no more water can pass through them than can be carried safely in the improved channels through the cities below. In this manner, the runoff of a flood like that of 1913, which lasted but two or three days, would be distributed over a period of about two weeks and its height would be correspondingly reduced.

The spillway-level capacity of the five reservoirs will be 840,000 acre-ft., or 60% of the total rainfall (1,415,000 acre-ft.) of the 1913 flood. At the beginning and ending of a flood the conduits through the dams and the improved river channels will pass almost all the runoff, leaving nearly the whole reservoir capacity "available for cutting off excess flow," or "peak of the load," which is beyond the channel capacity. Continuing, the report states:

In general, the greatest rate of flow through the cities below the retarding basins in case of a storm like that of 1913 would be approximately half as great as in 1913. The channel at Dayton when improved and enlarged will have sufficient capacity to carry somewhat less than half as much water as the maximum 1913 flow, and that at Hamilton to carry somewhat more than half, the remainder in each case being cared for by retarding-basin control.

The dams will be constructed of selected and compacted earth, with cutoff trenches filled with impervious material where demanded. Each dam will have a top width of 25 ft.

The conduits for passing the regular stream flow will be on rock foundation, through the base of the dams. The spillways, which will also be on rock, will be lined with concrete, will have their crests 15 ft. or more below the tops of the dams and will be designed to "pass safely all excess water in case of a flood twice as great as that of 1913." The report adds:

It is not anticipated that these spillways ever will come into use, since to bring them into action would require a greater storm than ever has been recorded in this part of the United States. They are added as an ultimate factor of safety and would provide security in case of a flood exceeding anything recorded in the history of the country.

Table 1 shows the main dimensions of the dams and Table 2 gives the estimated cost of the reservoirs, channel improvements and other items of the project.

Inasmuch as work may be prosecuted on all the channel improvements and on most of the dams at the same time, it is believed that the whole project could be substantially completed in three years' time.

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The Baltimore Sewerage Commission went out of existence on Feb. 1, through the resignation of its members on the virtual completion of its work. The sewerage and sewage-disposal system built by the commission under the direction of Calvin W. Hendrick, chief engineer, will be in charge of the Bureau of Sewers and will remain under the control of Mr. Hendrick, who now holds the position of chief engineer of the City of Baltimore.

Typhoid Fever has developed recently at Chicago and Milwaukee, both taking water from Lake Michigan. The Chicago cases are said by the Commissioner of Health to be due to surface water entering the pump pit at the 68th St. pumping station, and he has recommended that people in the southern part of the city boil the water or get inoculated against typhoid. Both cities are building new intake tunnels to take water farther from shore.

A Contractor's Magazine Blew Up in St. Louis, Mo., on Feb. 28, killing two women and injuring 64 other persons. Local estimates of property damage reach $100,000. Press dispatches state that the amount of explosives stored at the construction company's headquarters is variously estimated at from 500 to 3,500 lb., 1,000 lb. being the police record. The dynamite was to be used by the Cooney Construction Co. in building a sewer from the River des Peres to Manchester and Lanhan Ave. More than 100 glaziers were at work on Mar. 1 replacing the 5,000 windows broken by the concussion.

An Aërial Coast Patrol on the Atlantic and Pacific Coasts and on the Great Lakes is planned by a committee to be organized by Rear-Admiral Robert E. Peary. It is proposed to establish stations at intervals of 100 mi. all along the coast, each equipped with a sea-plane and operators. These sea-planes would take a position some 50 mi. off shore and patrol their respective beats continuously. It is urged that such patrols in the time of peace would be valuable in discovering wrecks, vessels in distress, etc., and that the operators thus drilled would be available for keeping watch for the approach of hostile ships in the event of war.

The Ontario Highways Act passed by the last session of the provincial legislature has recently gone into effect. Philay MacDiarmid, Minister of Public Works, now becomes Minister of Public Ways and Highways, with W. A. McLean as Deputy Minister of Highways. Provincial aid to county road construction is increased to 40% of the expenditure for this purpose, and in addition a grant of 20% to the cost of maintenance is provided for. A lesser degree of assistance will be given to township road construction. The act also provides for provincial aid to the construction of main or suburban roads by coöperative action between municipalities acting jointly, the provincial aid to be 40% of the cost, but not to exceed $4,000 per mi.

A Break in a 12-In. Water Main in Court St., Boston, a little after 8 p.m., Sunday, Mar. 5, flooded the basements of adjoining buildings, owing to difficulty and consequent delay in shutting off the water. There are two mains in the street at this point, and the gates in the undamaged one were closed before it was found out which one had burst. So much water had escaped that difficulty was experienced in getting at some of the gates, and it was necessary to close eight of them before the flow was entirely stopped, about an hour after the break occurred. Considerable damage was done in the basements of the buildings flooded, and at noon on Monday, Mar. 6, a steam fire engine and two gasoline diaphragm pumps were still at work removing water.

A High Masonry Viaduct at Penistone, England, on the line of the Lancashire & Yorkshire Ry., failed on Feb. 3, practically without warning. According to a brief account given in "The Engineer," of London, the viaduct was 60 to 80 ft. in height and consisted of a series of short span arches carried on high stone piers. It was about 30 ft. in width, carried a double-track railway and was built 67 years ago. About the middle of January a slight crack was observed in the parapet wall, but an examination of the foundations revealed no cause for anxiety. On Feb. 3, eight minutes after a main-line train had passed, one of the arches sagged under a switching engine slowly enough so that two men on the engine had time to jump off and run to a place of safety. Two of the arches fell, and the switching locomotive, which was over the adjacent pier, slid into the chasm. An official inquiry into the cause of the disaster is in progress, and "The Engineer" meanwhile conjectures that the accident may have been due to the effect of recent rains on the pier foundations.

Rear-End Collision between a New York Central coal train and a fast freight train carrying horses killed three men and seriously injured another at 4:37 a.m. on Mar. 3, on the Livingston Ave. bridge which crosses Broadway in Albany, N. Y. The cause of the accident is stated to have been the failure of the air brakes on the coal train, while on a down grade. The heavy freight train was thrown onto track No. 1 and into the rear of the third section of train 4, which was waiting at the tower east of the bridge for a signal to enter the station yard. An express train from Albany to Herkimer was just leaving the yard westbound on track No. 2 and was sideswiped by the runaway freight train, but not seriously damaged. On the rear of the express freight were two day passenger coaches, one of steel and the other of wood with steel underframe. In the collision the two passenger coaches telescoped. There was no one in the wooden car and only four passengers in the steel car, of whom three were instantly killed. Half a dozen steel coal cars piled up and crashed into the bridge, causing severe damage to that steel structure. D. W. Dinan, Division Superintendent of the New York Central Lines, conducted an investigation.

Investigation of Sewage Disposal in Los Angeles County, California, to take a year and cost $45,000, has been recommended by the Board of Sanitary Engineers recently appointed by the Board of Supervisors of Los Angeles County. The investigation would be made by the Board of Sanitary Engineers, composed of A. H. Koebig, chairman; G. P. Robinson, secretary (city engineer's office, Los Angeles); C. G. Gillespie, sanitary engineer of the State Board of Health; A. M. Brosius and Prof. Charles G. Hyde, Berkeley. The estimate of $45,000 includes a salary of $3,000 for each member of the board; two assistant engineers at $2,500 each; $5,000 for surveyors and draftsmen; $5,000 for studies of tidal currents and $1,000 for soil analyses and a study of ground-water conditions. The two grand divisions of the investigation would be the possibilities of ocean disposal and of treatment to fit sewage for use in irrigation without nuisance.

PERSONALS

Mr. J. B. Weddell has been appointed City Engineer of Olympia, Wash.

Mr. John C. Sullivan, of New York City, has been elected President of the Old Colony Construction Co., Boston, Mass.

Mr. Albert Wolstenholme, M. Am. Soc. C. E., Superintendent of Streets of Fall River, Mass., has been made City Engineer.

Mr. Karl M. Mitchell, City Manager of Sherman, Tex., resigned on Feb. 26. He was formerly at River Forest, Ill. of River Forest, Ill.

Mr. C. A. Mees, recently Assistant Chief Engineer of the Southern Power Co. at Charlotte, N. C., has resigned to engage in private practice.

Mr. R. A. Kiefer, recently with the Gardner Governor Co. at Quincy, Ill., is now in charge of the company's New York office, located at 303 Singer Building.

Mr. N. M. Curtis has been appointed Division Engineer of the Midland division of the New York, New Haven & Hartford Railroad Co., with headquarters at Boston, Mass.

Mr. J. G. Scott, resident engineer of the Southern Power Co. at Lookout Shoals, N. C., will succeed Mr. A. C. Lee at the company's hydro-electric plant at Fishing Creek, N. C.

Mr. R. L. Pearson has been appointed Division Engineer of the New London division of the New York, New Haven & Hartford Railroad Co., with headquarters at New London, Mass.

Mr. F. H. Moyer, formerly of Pittsburgh, has been appointed Chief Engineer of the Cambria Steel Co. He succeeds Mr. E. W. Clarke, who has been made superintendent of the rolling mills.

Mr. W. W. Harmon, formerly City Engineer of Grants Pass, Ore., has been engaged by the Oregon-Utah Sugar Co. as chief engineer on the construction of that company's new factory in that city.

Mr. E. M. Confer, former Superintendent of the Coosa Portland Cement Co., Ragland, Ala., has been appointed Master Mechanic of the Marquette Cement Manufacturing Co., La Salle, Ill.

Mr. Robert Rice has been appointed General Superintendent of the Missouri district of the Chicago, Burlington & Quincy Railroad Co., with headquarters at St. Louis, Mo. He succeeds Mr. F. H. Ustick.

Mr. E. A. West, Efficiency Engineer of the Portland Light and Power Co., Portland, Ore., has been appointed to succeed Mr. Roger W. Toll (recently resigned) as Chief Engineer of the Denver Tramway Co.

Mr. F. H. Ustick has been appointed General Superintendent of the Iowa district of the Chicago, Burlington & Quincy Railroad Co., with headquarters at Burlington, Iowa. He succeeds Mr. Robert Rice.

Mr. L. K. Rourke, M. Am. Soc. C. E., of Rourke & Sherman, Consulting Engineers, Boston, Mass., has been elected Treasurer of the Old Colony Construction Co. Mr. Rourke will continue his consulting practice in Boston as heretofore.

Mr. J. E. Lawton, M. Am. Soc. M. E., for the last nine years Inspector and Chief Inspector, Panama Canal, has resigned to accept a position as Consulting Engineer and Sales Manager of Ward & Co., manufacturers' agents, Washington, D. C.

Mr. John M. Bandel, Assoc. M. Am. Soc. C. E., Assistant Engineer, Baltimore Sewerage Commission, has been appointed Engineer of the Davison Chemical Co., Baltimore. He was formerly employed by the State Roads Commission of Maryland.

Mr. Paul J. Merrill has been appointed Assistant Chief Inspector of the Dayton Metal Products Co., Dayton, Ohio. Mr. Merrill was formerly located at Dearborn, Mich., as chief civil engineer on the erection of the experimental station at Henry Ford's residence.

Mr. A. C. Lee has been made Assistant Chief Engineer of the Southern Power Co., with headquarters in Charlotte, N. C. Until recently he was resident engineer on the company's large hydro-electric plant at Fishing Creek. In his new position Mr. Lee will have direct charge of the engineering department. He succeeds Mr. C. A. Mees.

Mr. Bertrand D. Barker, Assoc. M. Am. Soc. C. E., recently Superintendent of Construction for George A. Quinlan, Assoc. M. Am. Soc. C. E., Chicago, has been appointed Assistant Chief Highway Engineer of Cook County, Ill. He was formerly for several years engineer and superintendent of construction and tunnel work for George Jackson, Inc., New York and Chicago.

Mr. J. V. W. Reynders, M. Am. Soc. C. E., Vice-President and Director of the Pennsylvania Steel Co., on Mar. 7 resigned as General Manager of the Steelton, Penn., plant of that company. At the same time he announced the appointment of Mr. Quincy Bent, now Assistant to the President of the Maryland Steel Co. at Sparrows Point, Md., as General Manager of the Steelton plant. The Pennsylvania Steel Co. has been recently acquired by the Bethlehem Steel Co. interests. Mr. Reynders is a graduate of Rensselaer Polytechnic Institute and entered the employ of the Pennsylvania Steel Co. in 1892 as engineer in charge of the bridge and construction department. He was made Superintendent of this department in 1896, remained there until 1906, when he was made Vice-President, a Director and placed in complete charge of the works.

Daniel W. Mead, M. Am. Soc. C. E., and F. W. Scheidenhelm, M. Am. Soc. C. E., have announced their association in the practice of engineering, with offices in the Equitable Building, New York City. They will give their attention to reports, designs and construction covering hydraulic and electric developments, water-supply, flood prevention and reclamation works. Mr. Mead is a consulting engineer, professor of hydraulic and sanitary engineering at the University of Wisconsin and for many years has been engaged in the design and construction of water-works, power plants, dams, etc. He has recently returned from China, where he was one of the three consulting engineers engaged by the American Red Cross to investigate the flood conditions of the Yalu River. He is also consulting engineer to the Miami Conservancy District at Dayton, Ohio. His books on hydraulic engineering are widely and favorably known. Mr. Scheidenhelm has been located in Pittsburgh in consulting practice, subsequent to being in charge of the Cheat River developments of the Hydro-Electric Co. of West Virginia. His practice has been mainly along hydraulic lines, with particular reference to hydro-electric developments and dam construction. For the present, at least, Mr. Mead will divide his time between Madison, Wis., and New York, while Mr. Scheidenhelm will be permanently located in New York.

OBITUARY

Gen. William Sooy Smith died of pneumonia on Saturday, Mar. 4, at Medford, Ore., where he had resided since 1910. He was in his 85th year. A longer biography of General Smith will appear in a coming issue.

F. E. Brandis, a manufacturer of surveying instruments, died at his home in Brooklyn, N. Y., on Feb. 26, at the age of 70 years. Mr. Brandis immigranted to this country from Hanover when he was 12 years old. Scientific instruments were his life study, and he established himself in that business in Brooklyn in 1872. The firm—F. E. Brandis & Sons—is being carried on by the two sons who survive him.

William W. Mills, for many years in the employ of the engineering department of New York City and later a member of the Los Angeles, Calif., engineering corps, died at Las Encinas, Lamanda Park, Calif., recently. Mr. Mills was born in New York City and was a graduate of Rensselaer Polytechnic Institute. He came to New York several years ago to engage in subway engineering work, but when he became ill some months ago, returned to his home in California.

ENGINEERING SOCIETIES

COMING MEETINGS

NEW ENGLAND RAILROAD CLUB.
Mar. 14. Annual meeting in Boston. Secy., W. E. Cade, 683 Atlantic Ave., Boston.

WISCONSIN ELECTRICAL ASSOCIATION.
Mar. 16-17. Annual convention in Milwaukee. Secy., George Allison, Milwaukee.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 21-23. Annual meeting in Chicago. Secy., E. H. Fritch, 900 So. Michigan Ave., Chicago.

NATIONAL RAILWAY APPLIANCES ASSOCIATION.
Mar. 21-23. Annual meeting in Chicago. Secy., B. V. Crandall, 1824 Lytton Building, Chicago.

ILLINOIS GAS ASSOCIATION.
Mar. 22-23. Annual meeting in Chicago. Secy., H. H. Clark, 136 So. Harvey Ave., Oak Park, Ill.

Engineering Society of Wisconsin has elected the following officers for 1916: President, J. S. McCullough; vice-president, A. A. Babcock; secretary, Prof. Leonard S. Smith, Madison, Wis.

National Industrial Traffic League will hold a spring meeting in Baltimore, Md., at the Hotel Belvidere, Apr. 6 and 7. The president is G. M. Freer; the secretary, O. F. Bell, 413 Tacoma Building, Chicago, Ill.

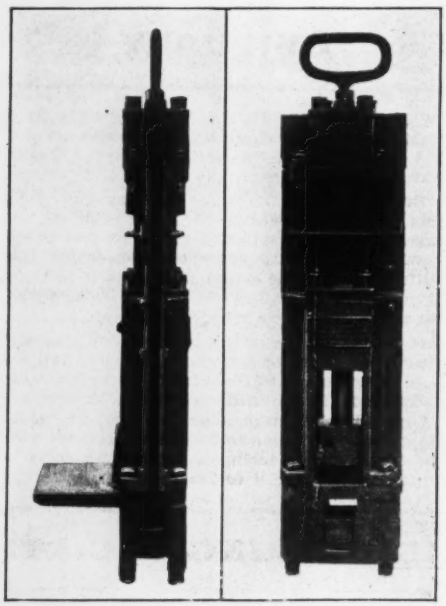
Building Officials Conference, which has been made a permanent organization, as explained in "Engineering News" of Mar. 24, has three classes of membership—active, associate and honorary. Active membership is open to governmental departments that administer building laws and also to individual officials connected with such departments or engaged in the formulation of building laws or ordinances. This membership includes not only state and city building departments, but also labor and tenement-house departments that have to do with the design and construction of buildings and also with members of commissions appointed to draft building laws. Associate membership is open to persons who have been, but are no longer, eligible to active membership. Honorary members may be elected as the result of distinguished services. Active and associate members are to pay annual dues of $5, which will entitle each member to a copy of the annual proceedings. The first dues are payable Oct. 1, 1916. The secretary is S. J. Williams, Madison, Wis.

Appliances and Materials

Small Steam Hammers for Sheeting

A 150-lb. steam (or air) hammer, for driving wood or light steel sheet piling in trenches, that is easily handled by a couple of workmen, has been developed by the National Hoisting Engine Co., Harrison, N. J. This hammer, designated as No. 7, is shown in the accompanying views. It was designed for 2-in. wood sheeting.

The frame has a step, on which the operator may stand to give the extra weight needed for most effective driving. The



LIGHT STEAM PILE DRIVER

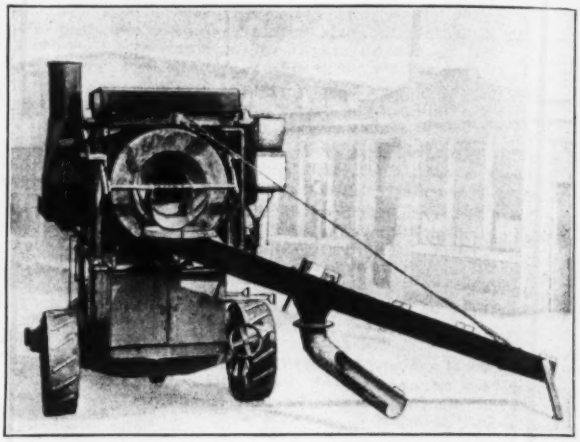
1-in. thickness of overhanging jaw on the striking-block seat allows working in close quarters. The mechanism is very simple, and the hammer can be taken down or assembled in about 15 min. No moving parts project beyond the frame. A simple slide valve on the top of the hammer is thrown back and forth by long trip rods, on each side of the cylinder, worked by lugs on the hammer. The cylinder is 2¼ in. in diameter and has a 4-in. stroke; the piston makes 350 strokes per min. A 5-hp. boiler, or 50 cu.ft. of air per min., is needed to run the hammer.

A similar hammer, designated as No. 6, weighing 650 lb. and intended for 3-in. wood sheeting, is also made by this concern. The cylinder is 3¼ in. in diameter and the stroke 6 in.; 275 strokes per min. is the rated speed. The front striking-block guide plate is only ¾ in. thick for working close up to a ranger.

High-Drum Mixers for Paving

The T. L. Smith Co., of Milwaukee, Wis., showed at the Cement Show, at Chicago, one of a new line of concrete mixers for paving work, known as the "High-Drum Smith Chicago Paver." This type is made in three sizes (with a smaller size of somewhat different details), but they all have the following special features: Wide loading skip, motor traction, chute distribution, automatic water-weighing device, rapid discharge and one-man operation. The accompanying view shows No. 507, and this description applies principally to that model.

The wide loading skip—varying from 7 ft. to 8 ft. 6 in.—permits two or three barrows to be dumped in it at once, thus facilitating the loading. The steam- or gasoline-engine drive, geared both to the mixer and to the tractor, is controlled from the distributing end of the machine, where one man may reach all the operating covers. The chute distributor, shown



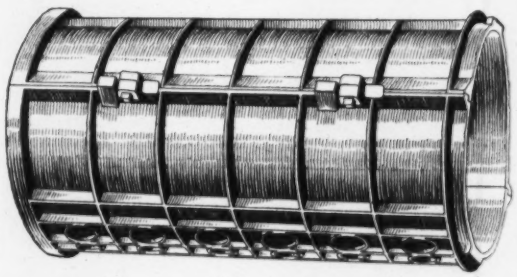
HIGH-DRUM MIXER FOR PAVEMENT WORK

in the view, has a 20° angle of flow, because of the high elevation of the drum, and is provided not only with a swivel at its base, but also with intermediate openings and an auxiliary chute that permit reaching spouting and good distribution of the concrete. The water-weighing device is new. It is automatic in action and can be so adjusted that a given amount of water is regularly emptied into the drum with each batch to be mixed.

* * *

Split Cast-Iron Culverts

Under the trade name of "Panama Culvert" the F. B. Zieg Manufacturing Co., of Fredericktown, Ohio, is making a new split cast-iron culvert pipe. It is claimed that the peculiar construction, shown in the accompanying sketch, provides



SPLIT CAST-IRON CULVERT PIPE

unusual strength and improved fastening for the halves, to make the pipe solid. These pipes may be obtained in 2- and 4-ft. sections of 8- to 36-in. diameters.

* * *

Gasoline Street Lamps

Gasoline street lanterns with double mantle burners for rural districts have been developed by the Coleman Lamp Co., Wichita, Kan. The tank holds 2 qt.—sufficient for 2 hr. burning. The lanterns are intended to be swung from any convenient mast arm with cable and pulley, but bails are provided for portability.

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BEST BETWEEN TRACKS

Kreolite Lug Wood Block is best for paving between tracks. It takes care of all expansion, so as to eliminate buckling, and the destructive side thrust on rails. It is extremely durable and reduces vibration to a minimum.

Kreolite LUG WOOD Blocks
"The Paving that's Saving"

prevents holding up of traffic by horses slipping and falling on the tracks. The lug insures sufficient spacing between blocks to give horses a toe-hold.

On account of these advantages Kreolite Lug Wood Blocks were selected by the Harrisburg Railways Co. at Steelton, Pa., for paving between tracks, as shown herewith.

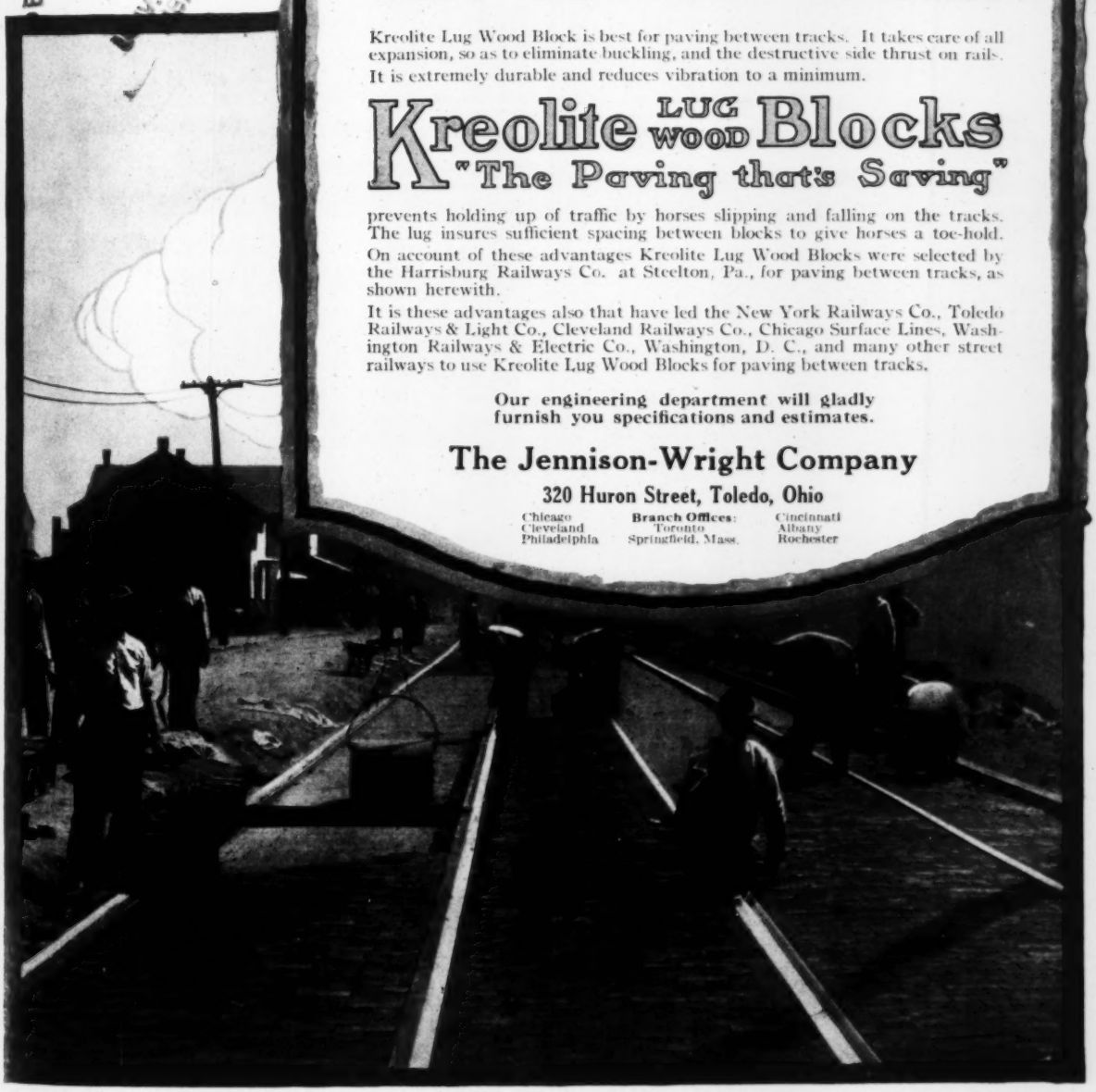
It is these advantages also that have led the New York Railways Co., Toledo Railways & Light Co., Cleveland Railways Co., Chicago Surface Lines, Washington Railways & Electric Co., Washington, D. C., and many other street railways to use Kreolite Lug Wood Blocks for paving between tracks.

Our engineering department will gladly furnish you specifications and estimates.

The Jennison-Wright Company

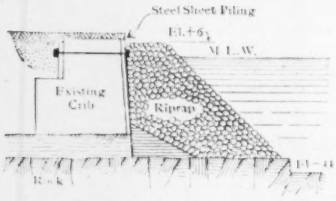
320 Huron Street, Toledo, Ohio

Chicago, Cleveland, Philadelphia — **Branch Offices:** Toronto, Springfield, Mass. — Cincinnati, Albany, Rochester



The straight line single wall of Lackawanna Steel Sheet Piling forming the north side of the 46th street cofferdam, New York.

The north side of the cofferdam was largely in shallow water and most of the way extended along an existing crib, so that at this location a straight single line of Lackawanna Steel Sheet Piling joined to the old crib was figured to have ample strength and watertightness to meet all requirements.



Accordingly, the special steel sheet piling section at the inner corner of the first cell, as shown above, was utilized for attaching the straight wall.

The single wall of steel sheet piling is tied back to the crib with 3-inch tie rods horizontally placed above low water as shown in the sketch. One end of each rod has a nut and washer bearing on the steel ranger (two 15-in. channels 40-lb.) inside the cofferdam and the other end has a similar bearing on a chock across the faces of two anchor piles driven in the adjacent crib pier.

LACKAWANNA STEEL COMPANY

General Sales Office and Works: Lackawanna, N. Y.

NEW YORK	CLEVELAND	ST. LOUIS
BOSTON	CINCINNATI	ATLANTA
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Licensees for the manufacture of Lackawanna Steel Sheet Piling

For Great Britain and British Colonies in the Eastern Hemisphere: Cargo-Fleet Iron Co., Ltd., Middlesboro, England. For France, Italy, Spain, French Colonies and Protectorates, Italian Colonies and Spanish Colonies in the Eastern Hemisphere: Cie des Forges & Aciéries de la Marine ed d'Homécourt, Paris, France.

Engineering News

VOLUME 75 MARCH 16, 1916 NUMBER 11

Brooklyn-Brighton Concrete Viaduct Completed

By W. H. Baker*

As stated in *Engineering News* of Sept. 9, 1915, the Brooklyn-Brighton viaduct was expected to carry traffic by the middle of August, 1915. Several influences, including the weather, worked against this expectation.

After the last section of the floor on the west half was poured on July 21, the entire floor was cleaned and all expansion joints made ready for the waterproofing, which was begun at the south end, July 26. During the ensuing week constant showers prevented much progress with this part of the work. However, enough was satisfactorily completed to permit the Cleveland Railway Co. to begin laying its track at the south end on Aug. 2. By Aug. 15 the entire west half was waterproofed and the railway track concreted in. The track consists of 95-lb. T-rail laid on Carnegie steel ties, Section M25, with concrete poured over the ties and the base of the rail to the level of the high points on the roadway concrete.

A 15-in. concrete curb, protected with Kahn curb bars, was built the entire length of the bridge. At the extreme right of the view, Fig. 3, reinforcing bars are seen projecting up from the concrete of the floor; later a similar row was built into the concrete of the east half. The "middle curb," which separates the two roadways of the bridge, was built around these bars, usually the next day after completing the floor. Two-inch forms were used, with 2x6-in. studs at close intervals, and a very attractive job was obtained. Fig. 3 also shows old ties placed longitudinally along the inside rail. They kept the concrete base of the track away from the space required for construction of the middle curb.

When the concrete for the west half was poured, wooden cores were placed at the middle of all floor-beams that would finally carry a trolley pole. Before the east half was poured, these cores were removed and sections of 10-in. steel pipe put in. Four ¾-in. bolts held these pipes in position until the concrete was all placed. Fig. 3 shows the trolley poles in place, set in the steel collars.

After the middle curb was finished, the trolley poles were plumbed, and the ¼-in. joint between the poles and the 10-in. collars was filled with sand to within 1 in. of the top. This inch allowed the joint to be sealed with

*Resident Engineer on Brooklyn-Brighton viaduct for Cuyahoga County; Court House, Cleveland, Ohio.

FIG. 1. A SECTION OF THE BROOKLYN-BRIGHTON VIADUCT, PARTLY BUILT
View of the whole bridge after completion is shown on the next page

FIG. 2. EAST SIDE OF COMPLETED BROOKLYN-BRIGHTON VIADUCT. The site of the old steel viaduct

grout; then a coat of black paint gave the base of the trolley poles a uniform appearance.

Pace Bros., Cleveland, began paving the west half of the bridge, Aug. 20, and finished grouting at 11:30 p.m., Aug. 25. The paving was granite block laid on a 1½-in. cement-sand cushion. After the blocks were laid and rammed, the surface was thoroughly flushed. The grout was immediately applied and worked in with brushes. Materials for paving were handled over a small track laid on the sidewalk (see Fig. 3).

The curb is of granite; the back face had a projection ¾ in. wide, to fit a recess molded in the vertical face of the concrete curb. The west halves of the north and south approaches were macadamized with 8 in. of slag below the subgrade of the final paving.

FIG. 3. PAVING WEST HALF (LOOKING NORTH ALONG ROADWAY, AUG. 24, 1915)

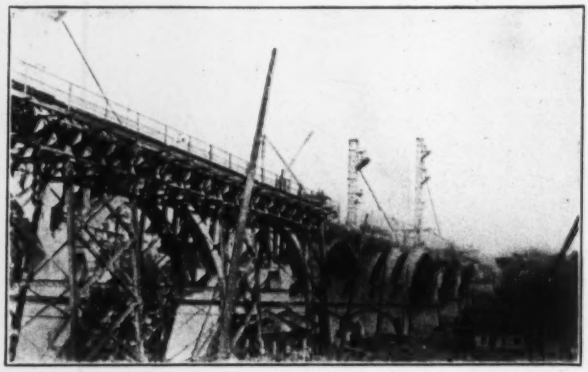


FIG. 4. STARTING WORK ON EAST HALF (NORTH PORTION OF STEEL VIADUCT RAZED)

On Aug. 26, the pavement being finished, all street-car traffic was carried by the new viaduct. Vehicle traffic was diverted in order to commence razing the old steel bridge. This traffic was not permitted on the new pavement until ten days after completion of the grouting.

Bates & Rogers Construction Co. started burning down the old bridge on Aug. 26. This work was done with the oxyacetylene flame and was continuously prosecuted, night and day, until Sept. 16, 1915. On this date, when 830 tons, or 75%, of the old viaduct had been removed, a point was reached such that the old bridge no longer interfered with the construction of the new viaduct. The razing of the old bridge was then delayed until later, and the last piece was taken away Nov. 22, 1915. Fig. 4 shows the work when the razing of the old bridge was stopped and the construction of the east half started.

About 2,700 cu.yd. of concrete was poured between Aug. 26 and Sept. 16. The last section of floor was placed Nov. 4, completing the main part of the viaduct. The last section of the approach retaining walls was poured Nov. 27, 1915. The fill at the south approach was completed Jan. 20, 1916. The sandstone railing was all in place on Feb. 25, 1916.

The method of setting this railing comprised placing the posts to line and grade on dowels set in the concrete, then fitting the panels to these posts. The parts of the railing were handled by a gantry crane running on steel rails. Blum & Delbridge, Amherst, Ohio, subcontractors for Bates & Rogers Construction Co., furnished and set the railing.

Flood Protection at Columbus

The project for flood protection of the City of Columbus, Ohio, and the Scioto River Valley by means of detaining reservoirs, has been approved in its general features by the Franklin County Conservancy District, and the engineers have been instructed to proceed with the plans. This work and the appraisal will occupy several months, but it is anticipated that the district may be ready to let contracts early in 1917.

Following the disastrous flood of March, 1913, the City of Columbus engaged Alvord & Burdick, consulting

CARRYING WEST 25TH ST. OVER BIG CREEK VALLEY, CLEVELAND, OHIO
was in the foreground of the view

engineers, Chicago, to investigate methods of flood protection. Their report (*Engineering News*, Sept. 25, 1913, and Apr. 2, 1914) recommended improving the Scioto River channel by means of a cutoff passing west of the city, at a cost of $11,263,000, of which the city's share would be $8,500,000. A bond issue for this was defeated.

The engineer's report had pointed out that reservoirs to retard flood waters would aid not only Columbus, but the entire Scioto Valley also. There was at that time no legal form available for coöperation between the city and the other districts affected, but in February, 1914, the Ohio legislature passed an act authorizing the organization of drainage and conservancy districts. Under this law the Franklin County Conservancy District was organized, and Alvord & Burdick were appointed its chief engineers.

The storm that caused the 1913 flood averaged 9.14 in. on the 1,614 sq.mi. of watershed above Columbus, but 2.33 in. of this was stored in two large natural basins. It is estimated that 8½ in. (93%) of this rainfall ran off, but the crest of the flood at Columbus was created by a rainfall on the watershed above of only about 6 in. in two days, half of this falling in the last 12 hr. of that period.

This flood was probably the greatest that has occurred in the valley. Owing to the increasing settlement, however, lesser floods (such as are on record) would be equally disastrous, so that there is increasing menace from smaller floods made dangerous by channel encroachments, levees, etc. In 50 years there have been about a dozen floods that have caused crop damage. The engineers believe that the 1913 flood will be repeated and probably exceeded.

The total loss from the 1913 flood in the Scioto Valley, exclusive of the watershed above Delaware and the tributaries below Columbus, was about $25,000,000. In addition, there were the indeterminate losses due to sickness, unemployment, interruption to traffic and business and the depreciation of property value. For a period of 20 years the flood loss averages about $1,500,000 per year. This sum will tend to increase and to result from the smaller floods as well as the exceptional great floods.

The plan submitted by the engineers and now approved by the district provides for two large detaining basins, or reservoirs, to hold back the flood waters and prevent rapid runoff. One is to be on the Scioto River above Dublin and the other on the Olentangy above Delaware. They will be formed by earth dams. Discharge tunnels in the rock of the hillsides will provide both for flood protection and water storage.

The Dublin dam will have a maximum height of 143 ft. and a base thickness of 980 ft. At the spillway level it will hold 11,148,000,000 cu.ft. of water, flooding 9,580 acres (255,925 acre-ft.). The Delaware dam will be 82 ft. high and 550 ft. thick at its maximum section; it will hold 7,109,000,000 cu.ft. of water, flooding 11,299 acres (163,202 acre-ft.). The dams will be founded on rock and made of unusual thickness.

Ample spillways capacity is provided. To overtop the dams would require a flood over three times as great as that of 1913.

The basins will be supplemented by improving the river channel at Columbus from the mouth of the Olentangy to Greenlawn Ave. This work will include widening and deepening the channel, raising the levees and paving their bends and replacing the destroyed bridges with reinforced-concrete arch structures. The channel will then have a capacity of 50,000 cu.ft. per sec. with a water level 6 ft. below the top of the levees. This is the maximum flood flow that can occur in connection with the detaining basins.

The project as a whole provides for a flood 45% greater than that of 1913. The engineers recommend also the enlargement of the district to include the cities of Delaware and Chillicothe, the flow land included in the basins and the bottom lands benefited along the Scioto and Olentangy Rivers below these basins.

The two detaining basins and the channel improvements will cost $10,125,000. About $2,500,000 of this is for the purchase of land for the basins. But as this area may be cultivated continuously, it will retain its agricultural value, so that it may be sufficient to lease the land or to acquire flowage rights. Water might be held in the Dublin basin to furnish an increased supply to Columbus during the dry period of the later part of the summer. The value of this service is estimated at $1,000,000. Bridge renewals also should not be charged entirely to the district. Deducting the above and other minor assets, the uncompensated cost is about $6,000,000.

Track Elevation and Station at Fort Wayne, Ind.

SYNOPSIS—The Pennsylvania Lines have elevated the tracks through Fort Wayne, on a solid fill between retaining walls, and have built a new passenger station at the street level. The street subways have steel bents and trough decks, the troughs being filled with concrete. The methods of carrying on the work are described.

The Pittsburgh, Fort Wayne & Chicago R.R. (Pennsylvania Lines) has elevated its tracks through Fort Wayne, Ind., and at the same time has built additional tracks and a new passenger station.

This stretch of work has a length of about 1½ mi. It is limited on the west by a double-track girder bridge over the St. Mary's River and on the east by a grade crossing with the Wabash R.R. at Hanna St. Beginning near the bridge there is now a grade rising eastward at 0.487 to 0.312% and covering the greater part of the distance, with a summit at Calhoun St. Beyond this a descending grade of 0.38% for 2,000 ft. comes down to the original elevation at Clay St. and is followed by a rising grade of 0.45% eastward. The maximum elevation above the old grade is about 10½ ft. Fig. 1 shows the new station and elevated tracks, and Fig. 2 is a view of the track elevation through the station.

When this work was undertaken, there were two main tracks—a running track for eastbound freight and an additional track at the station. The daily traffic averaged 18 passenger trains and 17 freight trains in each direction (half of the former being in the daylight hours). In addition there were numerous switching movements and work trains. No yards or railway connections were involved. There are now four tracks all the way from the river and six at the station, the inner ones for passenger traffic and the two outer tracks for freight traffic.

The profile and station layout are shown in Fig. 3. Part of the work is paralleled by the Wabash R.R., which had to elevate its tracks and build subways corresponding to those of the Pennsylvania Lines, as shown.

The new elevated line consists of a sand-fill between concrete retaining walls. These walls are of the gravity type, with vertical face, stepped back and with footings that project both in front and rear (Fig. 4). At one point the restricted width of property made it necessary to eliminate the front footing projection, and consequently the face was battered. The abutments of the bridges at the street crossings are of the same design as the retaining walls first mentioned, as shown in Fig. 5.

There are six street subways. The streets are depressed 6.7 to 9.9 ft., and the tracks are elevated 7.3 to 10.5 ft., the difference in elevation being 16 ft. 8 in. to 17 ft., except that at the two streets having street-car tracks it is increased to 19.8 ft. The sidewalks are not depressed to the roadway level, thus giving easier approaches and a saving in cost of construction.

In building the subways there was very little interference with street traffic, temporary driveways and footwalks being maintained most of the time. However, at certain stages of the work all street-car traffic had to be concentrated at one or other of the two subways having car tracks.

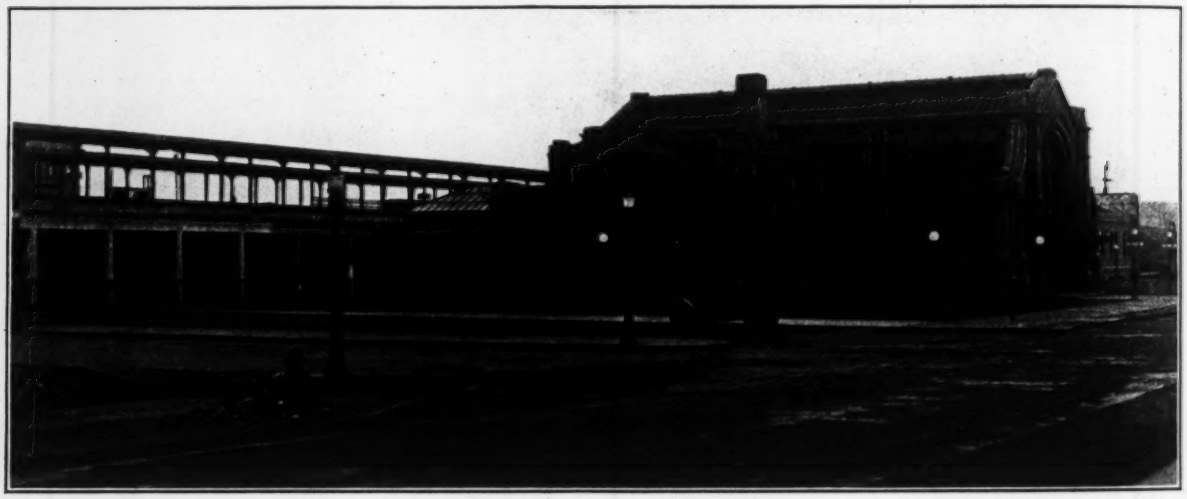


FIG. 1. NEW PASSENGER STATION AND ELEVATED TRACKS OF THE PENNSYLVANIA LINES AT FT. WAYNE, IND.

The bridges over the streets have steel trough-deck spans carried on steel bents and the abutments. Of the six bridges three have four spans, with three intermediate bents. The others have one, two and three spans, the single span being for a pedestrian subway. Fig. 5 shows the typical construction of the three-bent subways.

The bents have steel columns spaced about 13 ft. c. to c. These columns rest on concrete footings, and cross-girders are framed between their tops, with knee-brace connections to the columns. The trough deck is filled and covered with concrete, and the concrete extends over the outer sides of the deck as a fascia girder, both for appearance and to protect the steel.

The concrete deck is finished with ½ in. of neat cement. Upon this is a five-ply waterproofing course of

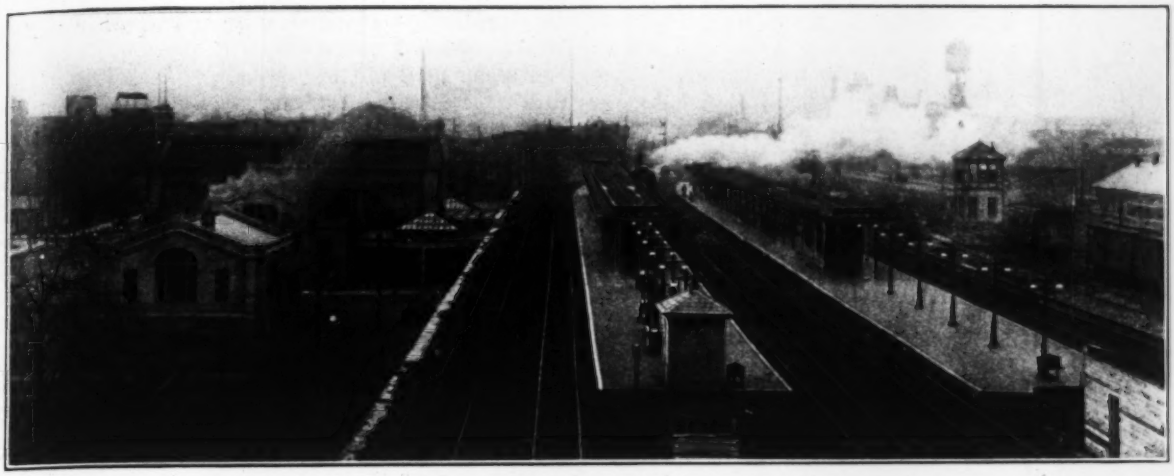


FIG. 2. NEW STATION AND TRACK-ELEVATION WORK AT FORT WAYNE, IND.
The smaller station building at the left is the express building. Between the main building and the retaining wall is a covered concourse

tarred felt and pitch, which extends across the deck and is covered with 2 in. of concrete, upon which the ballast is laid. The top of the concrete slopes down from the center of the bridge to the abutments, to give free drainage.

The columns are of H-section, composed of three web plates and four interior angles. There are four lines of angles on the corners of the side plates, and across these are riveted batten plates for the open sides of the column. The cross-girders have single webs, with flange angles and cover plates. The deck troughs are built up of plates and angles; they vary in width and depth according to the span.

New Passenger Station

The new station is shown in Figs. 1 to 3. It includes the main passenger building and an express building, both at the street level. Between the rear of the passenger station and the wall of the track elevation is a covered concourse, from which a concrete passenger subway 16 ft. wide and 9 ft. 4 in. high extends beneath the tracks. Two sets of stairways lead from the subway to the train platforms, which are 24 ft. wide and 800 ft. long. The platforms are covered for 433 ft. by shelter sheds, which have steam-heated waiting rooms at each end. A subway for baggage, mail and express matter connects with elevators leading to the platforms. It is 10 ft. wide and 12 ft. high and is located directly opposite the station center.

A water main with numerous branches terminating in hydrants on the platforms provides for supplying water to the drinking tanks in the cars. The steam for the waiting rooms on the platform is supplied from the station heating plant through pipes laid in a trench in the passenger subway and up through the wall to the track level, where they branch off. Where the pipes are buried in the ground, they are inclosed in split tile. The wires within the station layout are carried in six-way vitrified-clay conduits laid underground, except where they could be laid in the walls. At the two subways near the station the conduits are laid in the troughs of the bridge deck.

Through the station layout there are four passenger tracks, with a freight track on each side. Provision is made for an additional platform and pair of tracks, or eight tracks in all, as shown in Fig. 3. There are auxiliary tracks also, and crossover connections to allow for various train movements in the station area.

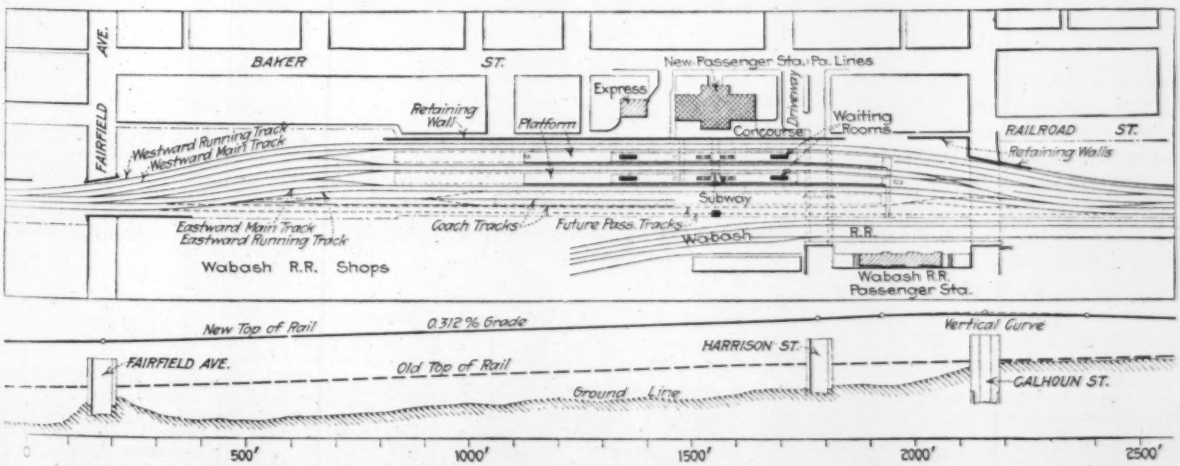


FIG. 3. PLAN AND PROFILE OF STATION LAYOUT AT FORT WAYNE, IND.; PENNSYLVANIA LINES

The construction was done by a combination of contract work and day-labor work. The first step was to lay a new 14-in. water main from the St. Mary's River to supply the tanks at the engine terminal and shops—a distance of about 0.6 mi. This pipe was laid outside the track elevation and took the place of an old 12-in.

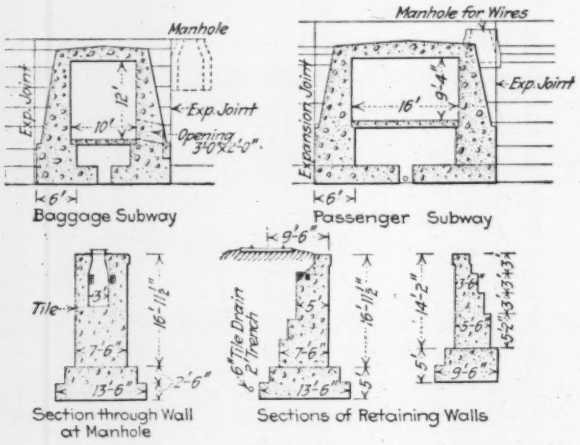


FIG. 4. RETAINING WALLS AND STATION SUBWAYS

main that it was not considered advisable to take up, as its salvage value would have been very small.

The main part of the fill was made with sand from borrow pits at Winona Lake and Grovertown, Ind., 37½ and 74½ mi. distant, only one pit being in use at a time. The grading contractor loaded the cars at the pit with a steam shovel. The railway company furnished the borrow pits and did all trackwork there. It also supplied the trains of gondola cars, spotted the cars at the shovel and hauled the trains to and from the work. Engines and crews were called as needed, the railway company having an inspector at the pit who reported conditions to the office at Fort Wayne.

The tracks were elevated singly and in turn, each track being raised and put in service before the next one was disturbed. In this way, following the method described later, only one track at a time was out of service, and a double-track line was maintained for traffic.

The method employed in elevating a track was as follows: The track to be raised was abandoned and torn up, and an Ohio locomotive crane with a clamshell bucket started unloading sand from cars standing on the adjacent track, these cars being spotted within reach of the crane by the railway company. The track on which the cars were spotted had to be cleared when necessary, in order not to impede traffic. Cribbing of old ties was built as the work progressed, to keep the fill from encroaching upon the adjacent track. While the crane was placing the fill for this track, a piledriver, operated by railway-company forces, was driving piling at the streets where subways were to be built. As soon as the falsework and filling for a track were completed the track was relaid on the higher elevation and placed in service. Work on the next track was then proceeded with as before, and so on until all the tracks had been raised to the proper elevation. Where the fill was so wide that the sand could not be unloaded from existing tracks (as at the passenger station), temporary tracks were built and thrown as required as the filling progressed.

The same method was used for the west end of the work (adjacent to the river), except that limestone screenings were used for filling and were unloaded by hand by company forces. For the extreme east end of the work, sand from Gary, Ind., was used. It was loaded and unloaded by hand, the amount of fill not being sufficient to warrant the use of a steam shovel at the pit or an unloading crane at the fill.

Concreting and Steel Erection

All concreting was done by contract. The ¾-yd. mixer was mounted on a flat-car and discharged the concrete directly into chutes leading to the forms. Behind this were cars containing concrete materials, which were delivered to the mixer in wheelbarrows. The mixer car, with material cars attached, was placed on a track on the trestle at the street where concrete work was being done. This track was put out of service temporarily by a special order and restored to service when no longer needed for the work train.

Each section of abutment had to be completed during the day. The same method was employed in building the retaining walls, except where a temporary track was available.

The erection of the steelwork for the bridge was handled by the railway company's forces and in the following manner: A track was put out of service and the temporary trestle torn down, to permit placing the steel. After it had been placed, the parts were riveted together and the track was placed in service again on stringers laid upon the steel. The steel for another track was then placed, and operations continued as before. Temporary tracks were used from which to place the steel, in case it could not be erected from one of the running tracks on the trestles.

A 50-ton Bucyrus railway wrecking crane was used in placing the steel for some of the bridges. In other instances a 15-ton Ohio locomotive crane or a long-boomed derrick car was used. Part of the riveting was done by hand and part by pneumatic hammers, a shop engine being kept constantly on the work to furnish air.

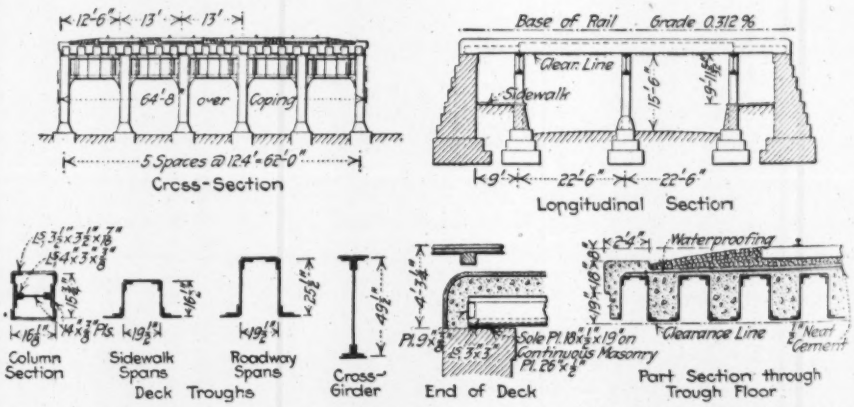


FIG. 5. TYPICAL CONSTRUCTION OF THREE-SPAN SUBWAY ON TRACK ELEVATION AT FORT WAYNE, IND.

The concrete filling was placed in the troughs of the bridges by the contractor, who had the use of tracks for his plant as required. The tracks were given up temporarily and placed in service again as soon as the concrete had hardened sufficiently to carry traffic. Waterproofing was subsequently done under the same conditions as to traffic.

All trackwork was done by company forces. All street work, except placing the concrete curb walls, was done by the City of Fort Wayne. These curb walls were built by the railway company, in order to insure uniform concrete work around the columns.

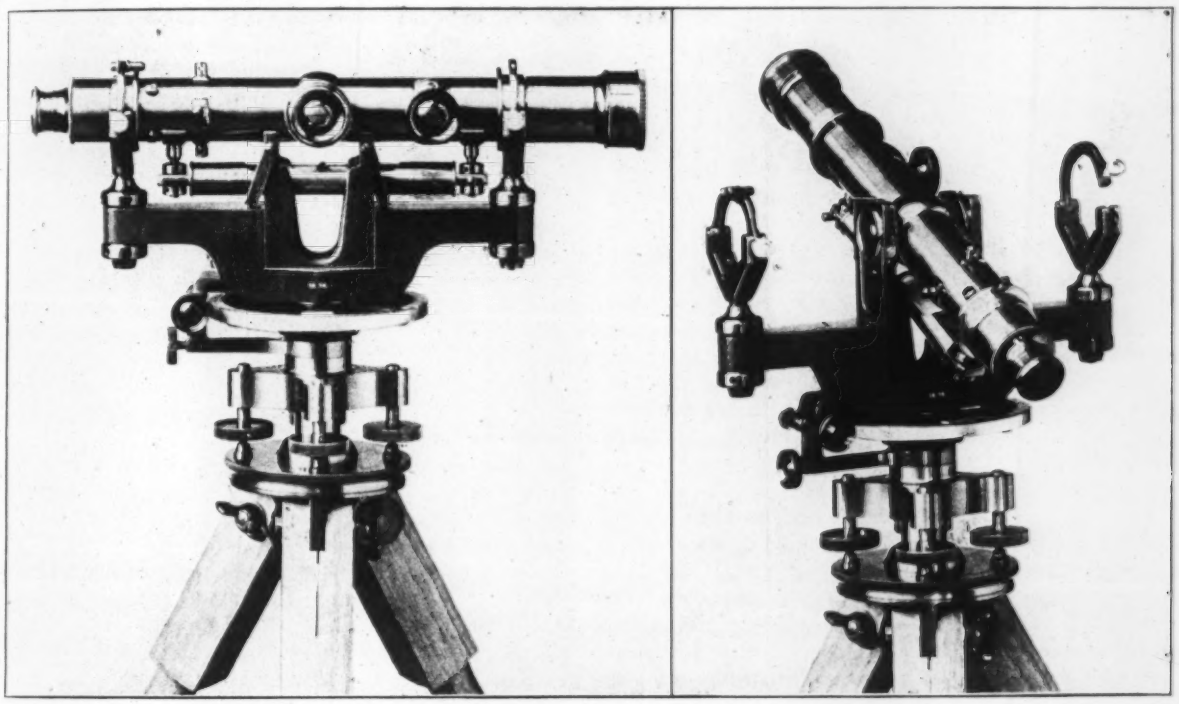
The design and execution of the work were under the direction of Robert Trimble, Chief Engineer of Maintenance-of-Way of the Pennsylvania Lines. The steel superstructure of the bridges was under the direction of J. C. Bland, Engineer of Bridges. The track elevation was in immediate charge of F. M. Graham and Guy F. Scott, who were the Division Engineers at different times during the progress of the work.

The principal contractor was the Herman Tapp Construction Co., of Fort Wayne, Ind., which sublet the grading to the France Co., of Toledo, Ohio. The George B. Swift Co., of Chicago, had the contract for the station buildings, concourse and paved driveways, and also for the platforms with shelter sheds and waiting rooms. The steelwork was divided between the Fort Pitt Bridge Works, Toledo Bridge and Crane Co., Mt. Vernon Bridge Co. and the Riter-Conley Manufacturing Co.

This work was commenced in 1910 and completed during 1915. The cost, including the station site and buildings, was somewhat over $1,000,000. Grade separation is now in progress at the Wayne Trace Crossing, outside the eastern city limits, but it is independent of the work described in this article.

Convertible Level and Transit

A new convertible or tilting Y-level that can be used also as a modified form of transit is shown in the accompanying illustrations. It is intended particularly for the use of contractors and on road or ditch construction work. The view at the left shows the instrument as a level, with the telescope carried in the Y-standards attached to the ends of a drop frame or crossbar. The standards for use with the instrument as a transit have the lower portions cast as part of this crossbar, and the upper portions are hinged to them, being folded down so as to clear the telescope, as shown. To use the instrument as a transit, the telescope is removed from its position in the Y's (parallel to the bar), and is placed crosswise to the bar in the standards, the upper parts of which are raised for the purpose. It is termed a modified transit for the reason that the telescope cannot be turned through an entire circle, but the drop frame admits of movement through an angle of 90°, from 45° above to 45° below the horizontal line. The conversion can be made in a few seconds. A special feature is that there are no detachable parts to be lost or mislaid. The transit standards form a permanent part of the instrument, the upper portions being hinged so that they can be folded out of the way when not in use. This instrument is manufactured by the David White Co., 419 East Water St., Milwaukee, Wis.



A NEW CONVERTIBLE LEVEL AND TRANSIT FOR USE ON CONSTRUCTION WORK
The instrument is shown at the left as a level and at the right as a transit

Steam Power Plant with 96.4% Load Factor—Four steam-engine driven generators in the Perth Amboy, N. J., works of the Raritan Copper Works operate usually for over 95% of the total time. In the five months from August to December these engines (four-cylinder triple-expansion 21-, 38-, 44- and 44x48-in. Nordberg-Corliss engines driving 900-kw generators) averaged 96.4% of total possible time in service. The lost time was consumed in adjusting valve gears, etc.

Pneumatic Concrete Mixing and Placing, New York Subway*

By A. E. Comstock†

On Section 5 of the Broadway-Fourth Ave. subway, which includes the two-track structure on 59th and 60th St. from Seventh Ave. east to Second Ave., the concrete lining of the tunnels and other structural concrete are both being placed by compressed air. The machine used for this purpose is designed for both mixing and placing concrete.

It consists of a drum about 4 ft. in diameter by 2 ft. deep, on the under side of which is attached an inverted cone-shaped section extending about 3 ft. below the bottom of the drum and terminating in a 6-in. discharge pipe. On top of the drum is a feeding hopper, and inside is a horizontal door, sliding in cams so adjusted that, in closing, it is brought tightly against a gasket on the top of the drum, thus making an air-tight lock. The door is operated by a hand lever connected to it by a piston rod passing through the drum.

The cone-shaped section underneath the drum is fitted near its top and bottom with about 12 small inlet pipes, through which air is forced for the purpose of agitating the materials until they are thoroughly mixed before the mixture is driven through the discharge pipe to the forms. The discharge pipe is attached to the cone by a T-connection, from the free end of which a 2-in. pipe leads to the compressed-air reservoir, and another 2-in. air connection is located at the top of the drum.

When the process of mixing has been completed, the air is turned on at both connections, the air through the upper one forcing the concrete down into the discharge pipe, while the air through the lower one forces the concrete forward to the forms.

When the machine was first put into operation on this contract, the agitators were not used, as it was thought that the materials would become sufficiently mixed in transit through the discharge pipe and upon being deposited in the forms. Repeated trials made by this method proved unsuccessful. The aggregates failed to mix properly with the cement and water and were deposited in the forms in a condition varying from very wet to dry. Being deposited under an initial pressure close to 100 lb., the materials that had become only slightly wet were compacted to such an extent that rehandling was difficult and involved considerable loss of time. Furthermore, an appreciable amount of sand and cement that had not come in contact with the water was blown clear of the forms. Later developments showed that dry materials had a tendency to clog the pipe more frequently than those thoroughly mixed with water.

Various methods and contrivances were used to overcome these difficulties and obtain a better mix, but without satisfactory results. An attempt was then made to use the agitators, but these were found to have become obstructed with cement to such an extent that it would have required a considerable loss of time to clear them. Moreover, it was the opinion of the engineers that the agitators would fail to do the work for which they were designed; for when the materials are placed in the mixer, they drop first into the discharge pipe and fill upward from that point, and all materials below the lower set of agitators would not be affected by them. Also, the agitators would act simply as an air inlet and would immediately cause the discharge of the materials from the machine before mixing could take place.

An arrangement was then made by which the materials could be thoroughly mixed to the proper consistency before being placed in the air mixer. This method, with proper spading and sufficient rehandling in the forms when necessary to insure an even distribution of materials, has resulted satisfactorily and is the method now being used. The arrangement of the plant at the mixing point was such that with a slight modification this method of mixing could be used continuously.

Two storage bins, one for sand and one for gravel, each with a capacity of about 12 cu.yd., are erected with their tops at the level of the street, in such a position that trucks discharge into them conveniently. At the bottom of each bin is a gate through which the materials are run into a hopper gaged for measuring the sand and gravel. At this point there is a platform, covered and waterproofed, where the cement is handled and temporarily stored, on which is located a water tank fitted with an improvised measuring gage and connected to a steam boiler for the purpose of heating in cold weather. The steam pipes also pass through the storage bins for the same purpose. At the bottom of the measuring hopper is one gate which, when opened, allows the sand and gravel, to which the cement has been added, to run together into the mixer.

Before experimenting with the air mixer, a rotating mixer had been in use in placing the track floor and wall benches. Space was provided in the arrangement of the plant to set aside one mixer in case it was desired to use another. Upon the failure of the air machine to mix properly, it was replaced by the rotating machine, lowered to a position above the air machine and so arranged that the rotating machine could thoroughly mix the materials and discharge into the latter with the previously mentioned satisfactory results.

Points To Consider in Using Air Conveying

The discharge pipe should be laid in the most direct line between the mixing point and the forms, avoiding bends as much as possible, since all bends retard the passage of concrete through the pipe, encourage congestion and increase the time of transit as well as the consumption of compressed air. Where bends are necessary, they should be sweeps of large radii, about 15 or 20 ft. Short bends of 4 or 5 ft. were used on this contract in the early experiments with this method and were found to clog more frequently than those of larger radii and to wear through in a few hours, with consequent loss of time for repairs.

When the pipe becomes clogged, sounding at the point of congestion will usually loosen the obstruction; but it is sometimes necessary to remove the obstructed part and clear it by other means. At every point where the pipe changes direction there is a decided shock when the concrete strikes the bend. It is therefore necessary to have such points securely braced, in order to prevent un-

*Extract from paper by Robert Ridgway, Engineer of Subway Construction, Public Service Commission, New York City, entitled "Some Features of Concrete Work on Subway Construction," New York City, and read before the American Concrete Institute, at Chicago, Feb. 14, 1916. This particular part of the paper was prepared by Mr. Comstock.

†Assistant Engineer, Public Service Commission, New York City.

necessary strain on the joints, particularly at the outlet, where the shock would otherwise cause a shaking and consequent loosening and displacement of the forms, if there is any contact between the pipe and the forms—a condition that cannot always be avoided. The original position of the outlet of the discharge pipe should be located centrally in the forms, since each change of pipe means additional loss of time for bracing.

In passing through the discharge pipe, especially over long distances, the concrete has a tendency to spread out along the bottom rather than move in a solid mass through the full section of the pipe. If this condition continued to the outlet of the pipe, much of the air would pass over the materials, resulting in a loss of pressure, a longer

VIEW IN 59TH ST. SUBWAY, MANHATTAN, SHOWING PIPES FOR PNEUMATIC CONVEYING OF CONCRETE

All concrete shown here was mixed in a rotary batch mixer and was transported to the forms by the pneumatic method

time in discharging and a separation of materials at the outlet. In order to avoid this it is necessary to have a rise, vertical or nearly so, at or near the point of discharge, so as to cause the concrete to fill the pipe completely and to discharge more uniformly.

In order to obtain the proper distribution of concrete in the forms with as little rehandling as possible, a flexible rubber pipe was attached at the outlet, with the idea of directing the flow to different points, as desired. This proved practically useless, as the pipe buckled, was difficult to control and was soon worn out. It was therefore replaced by a T-connection that could be turned to any desired angle in a vertical plane and satisfactorily provided the required distribution.

This method of placing concrete is particularly adapted to filling tunnel arches, the discharge pipe being laid along the crown of the arch to about the middle point of length of the section and the T turned alternately on each side until the arch is filled to the level of the crown. The T is then removed and replaced by a piece of straight pipe extending to within a few feet of the far end of the form, the whole length of pipe inside the form is raised to a position tight against the rock along the highest available line, and concrete is pumped in until the arch is filled up to the outlet of the pipe. The pipe is then removed and replaced by a shorter piece extending about 6 in. into the form at the most advantageous high point; the bulkhead is sealed and the blowing of concrete resumed until the arch is filled to the point of refusal. The pipe is left in place until the concrete has set long enough to be firm, when it is removed and cleared of any concrete remaining in it. It is impossible to seal completely all voids in the roof of a tunnel by this method of placing concrete, unless the rock breaks fairly smooth without leaving pockets above the general surface.

Care must be taken to avoid overtaxing the forms, as the high pressure of air added to the weight of the concrete is likely to displace or rupture them, and such an accident actually occurred at one point on this work. On this contract the point of deposit farthest from the mixer is about 500 ft., and the time required to discharge a two-bag batch of concrete over this distance varies from 30 to 40 sec. Each batch is mixed for about 1 min., during part of which time the previous batch is discharged into the forms. Under favorable conditions about 1½ min. are required to mix and place each batch; but on account of time lost in spading the mix in the forms, occasionally changing the position of the pipe, clearing obstructions and waiting for the proper amount of initial air pressure, a fair average between batches may be assumed as about 3 min. The time required decreases in length as the point of deposit approaches nearer to the mixer. It therefore requires about 12 hr. to line a section of tunnel roof 25 ft. long, which contains 80 cu.yd. of concrete, including excess.

At the present time there are two single tunnels and a double tunnel, each about 300 ft. in length, being constructed by this process. Part of this double tunnel is open-cut construction, where complete tunnel sections above the track floor, each 10 ft. long, are being poured at one time as monoliths. The work is in progress at three points, thus keeping the machine in practically constant use. Steel forms and carriers are being used for tunnel sidewalls and timber arch forms on steel carriers for the tunnel roof.

The Busiest Street Intersection in the world is in New York City at Fifth Ave. and 42nd St., according to a recent count by the Traffic Committee of the Fifth Avenue Association. According to this investigation, between 3:30 and 4:30 p.m. on the day of the test, 1,149 vehicles were counted proceeding south. J. Bernstein, who made the count for the committee, stated that the top figure for the Strand, London, is 900 vehicles per hour, and in Paris the record is 600 in an hour on the Boulevard des Capucines. The count revealed other interesting statistics: Of the vehicles on Fifth Ave. at 42nd St. 92% are now motor driven. Between 8:30 a.m. and 6:30 p.m., under unfavorable weather conditions, 7,762 passenger vehicles were counted northbound, of which 300 were commercial (of these 60% were horse drawn), while 600 busses passed in the 10 hr. The grand total was 8,862. The traffic peak was between 2:30 and 3:30 p.m. Southbound in the avenue the total for the day was 7,190, consisting of 6,388 passenger vehicles, 198 commercial and 604 busses. On 42nd St. the total from east to west was 4,716; and from west to east, 3,909.

Railway Ditching Trains

The work of cleaning roadway ditches and widening cuts is now being done on a number of railways by means of a short ditching train having two air-operated dump-cars and a power ditcher instead of by a long train of flat-cars with ditcher and unloader plow.

The smaller train of dump-cars can be unloaded at almost any point for filling bridges, widening banks or wasting the spoil, so that the length of haul from the cut to the dumping point is usually only from 1 to 4 mi. As the train can be handled rapidly and requires only a short length of sidetrack to hold it, it can easily be kept out of the way of regular trains, thus minimizing the interference with traffic without losing time for its own work.

The cars are operated by air and controlled from the locomotive. As they throw the load clear of the ballast, they can be dumped while the train is moving. Another important point is that such a train can be handled readily by a light locomotive. The crew will consist of about 8 men.

The complete train consists of a locomotive, two 20-yd. dump-cars, a ditcher, a spreader-car and a caboose. Sometimes there is a water-tank car in addition. The ditching machine, built by the American Hoist and Derrick Co., of St. Paul, Minn., is a small revolving steam shovel with ½-yd. bucket. It is mounted on a portable track on a flat-car placed between the two dump-cars, so that it can load them both. It is so connected that, while the train is running, the machine can pump water from the tender or tank-car to its tanks, thus saving time otherwise lost in taking water. The two cars can be loaded in about 30 min.

On one road, with an average haul of 1 to 4 mi., the train makes 10 to 20 trips per day. In that time it handles more material than a work-train of 15 flat-cars (10 cu.yd. per car) with ditcher and unloader plow. The latter train requires a crew of about 12 men and loses time in shifting the ditcher, plow and plow cable at each trip. With such a train the ditcher travels along it, loading each car in turn as it comes to it.

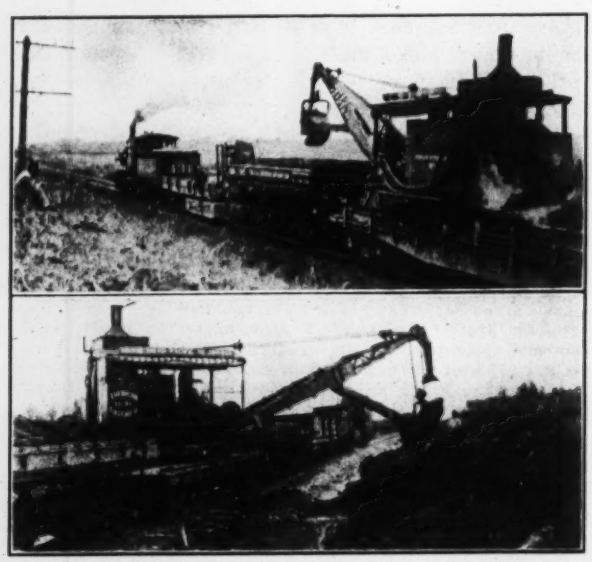


FIG. 1. DITCHING TRAIN WITH POWER DITCHER SERVING TWO DUMP-CARS

The diagram, Fig. 2, has been prepared by the builders of the ditching machine for estimating the amount and cost of work to be done in this way with a train having one ditcher and two 20-yd. dump-cars. The diagram is for ditches 2 to 3 ft. deep. The excavating capacity is

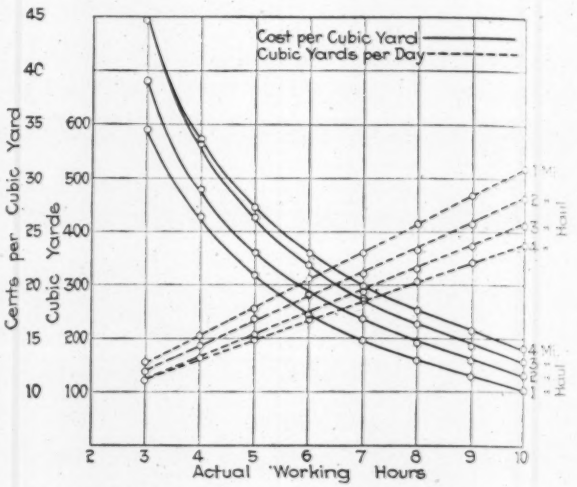


FIG. 2. COST AND PERFORMANCE OF WORK TRAIN WITH POWER DITCHER AND DUMP-CARS

60 yd. per hr.; speed of train, 20 m.p.h.; distance to switch or dump, 2 mi. The daily cost of work train (wages, fuel, oil, interest and depreciation) is taken at $53.76. For a ditch 2 ft. deep and 6 hr. productive time per day the work will amount to 280 cu.yd. at about 20c. per yd. Where there is much ditching to be done, the train may have four dump-cars and two ditchers (each ditcher between two cars).

Tunneling for Water in Oahu

By Kenneth Q. Volk*

The Oahu sugar plantation is situated on the Island of Oahu, in the Hawaiian group, upon which is the City of Honolulu. In 1911 the company owning this plantation was pumping about 80,000,000 gal. of water daily for the irrigation of cane, operating the pumps against average lifts of 420 ft. and running them 300 days out of the year. California oil was used for fuel.

The amount of water put on the land is surprisingly great. M. M. O'Shaughnessy estimated that in 1909 there was 250,000,000 to 300,000,000 gal. of water being pumped daily by various plantations on this island for the irrigation of cane. The island is divided by a mountain crest on the windward, or northern, side. The precipitation ranges from 40 in. at sea level to 100 in. on the divide, with rainfalls of but 15 to 20 in. on the lee side of the island, where are situated most of the cultivated lands. The drainage basins on the windward exposure of the island are short and precipitous.

In order to avoid the heavy pumping costs the Oahu plantation decided to drive a series of collecting tunnels on the windward side of the island to pick up a number of streams, which were to be brought under the main range of mountains in a long tunnel to the southern slope, at an El. 750 ft. above sea, from which point the

*Engineering offices of J. B. Lippincott, Central Building, Los Angeles, Calif.

water would be distributed over the plantation. This enterprise was reported upon for the company by a number of engineers at different times, including M. M. O'Shaughnessy, James D. Schuyler and J. B. Lippincott. Mr. Lippincott laid out the general plan for the work in 1911. The main tunnel lengths are as follows:

	Ft.
Kahana collection tunnels.....	8,677.9
Waikane collection tunnels.....	15,943.1
Main tunnel through the crest...	14,567.0
South-side tunnels	19,211.6
Total	58,399.6

There are also several miles of canals and siphons on the southern side of the island.

Jorgen Jorgensen is the contracting engineer. Charles H. Kluegel and James M. Young have been the engineers representing the company during the construction. On Dec. 22, 1915, the main tunnel was holed through, and the work has been successfully accomplished.

The rock through which the excavation has been driven is volcanic, and the distinct feature of the work was the enormous volume of water encountered. When the operations were well under way on the northern, or upper, end of the tunnel, flows of 30,000,000 gal. daily were encountered, while on the southern, or lower, end from 10,000,000 to 15,000,000 gal. occurred. The main tunnel is not now producing as great a flow as this, but it is delivering a very substantial volume.

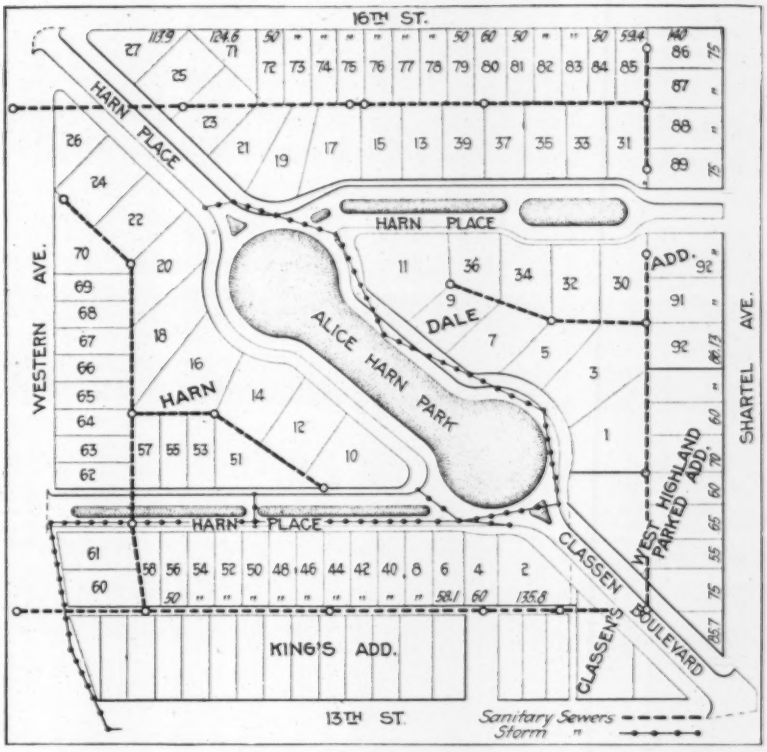
The work was done for the Oahu plantation by the Waiahole Water Co., of which George Rodick, of Honolulu, is president.

This account is written merely to chronicle the completion of an important engineering undertaking. It is to be hoped that some of the engineers in intimate charge of the work during its construction may give the profession the benefit of some of their experiences in much greater detail than is contained herein.

Some Crazy City Planning

Just to illustrate how crazy a city plan can be made and just to give an idea of some of the intricate engineering problems such a crazy city plan gives rise to, the accompanying sketch is shown. It illustrates a recent addition to the street system of Oklahoma City, practically forced upon the city against the remonstrance of its engineers by an eccentric lawyer. In dedicating certain plots to the city as public parks the grantor has obligated the city to call every street within the layout "Harn Place," with the additional odd obligation that the houses are to be numbered as the lots now are! A study of the plan will prove interesting.

The lots and streets were originally laid out when most of the land was in plowed fields. Wooden hubs were used for corners and a large part of them have been plowed out. It was recently necessary to draw plans and specifications for the sewering and paving of this district. Since it would be practically impossible to give in words a conception of the difficulties involved in this work, a great deal has to be left to the imagination of the reader and to an inspection of the plan.



LAYOUT OF PAVEMENTS AND SANITARY AND STORM SEWERS OF A RECENT ADDITION TO OKLAHOMA CITY

To determine the amount of paving and grading, it was first necessary to establish the street and curb lines. With many of the original hubs gone, the difficulties of this work can be more easily imagined by the experienced surveyor than described here. Had it not been that the hubs at the centers of the two circular park plots were found, the task would probably have been impossible.

The design of sanitary sewers was complicated by the practically inviolable custom which requires that they be placed in alleys in the rear of the lots. As these lots had no rear alleys, it was necessary to locate the sewers on the division lines between the rows of lots. This procedure, it will be seen, necessitated accurately establishing all the rear corners of the lots, just as the survey for the pavement required the front corners to be located. Assistant City Engineer Hart spent many weeks reproducing these lot lines before plans could be drawn.

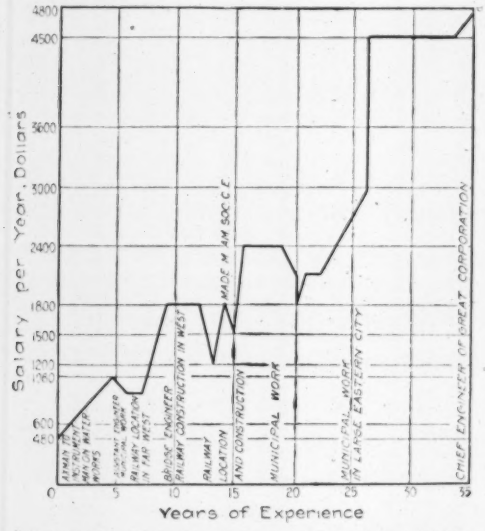
The design of the storm sewers required considerable ingenuity to care for surface drainage on an area with elevations varying by differences up to 30 ft. These sewers and catch basins are as shown in the street areas. There is a hump in the middle of Alice Harn Park, so that the surface water of the east boulevard drains both ways into catch basins on the curves.

This layout makes it obvious that if a real-estate owner, even though he be a lawyer, wishes to dictate in city-planning matters, he had better consult someone versed in the art, or at the least someone conversant with the elements of municipal engineering, before he formulates his dicta.

Thirty-Three Years of the Life of a Successful Engineer

The ups and downs of a civil engineer's life—and not an average engineer either, but one who was unusually successful—are admirably illustrated by the accompanying chart. The end of the chart, when the man became chief engineer of a great corporation, is not shown, but is left to the imagination; the chart is concerned only with the various steps by which he achieved this distinctive berth.

The 10 yr. in western railway construction is typical of the experience of a great many of the more elderly



EXPERIENCE CHART OF A CIVIL ENGINEER

engineers of today, only this one was more than usually successful in being continuously employed.

This man was not a technical graduate. Probably the majority of his contemporaries were not. Nevertheless the chart will bear study by young technical graduates and prospective graduates. Salaries and conditions have not changed essentially in the lower grades of the profession, and bearing in mind that this man could be considered a most successful engineer, in all worldly senses at least, a study of the chart ought to help dispel any great anticipations of large financial reward.

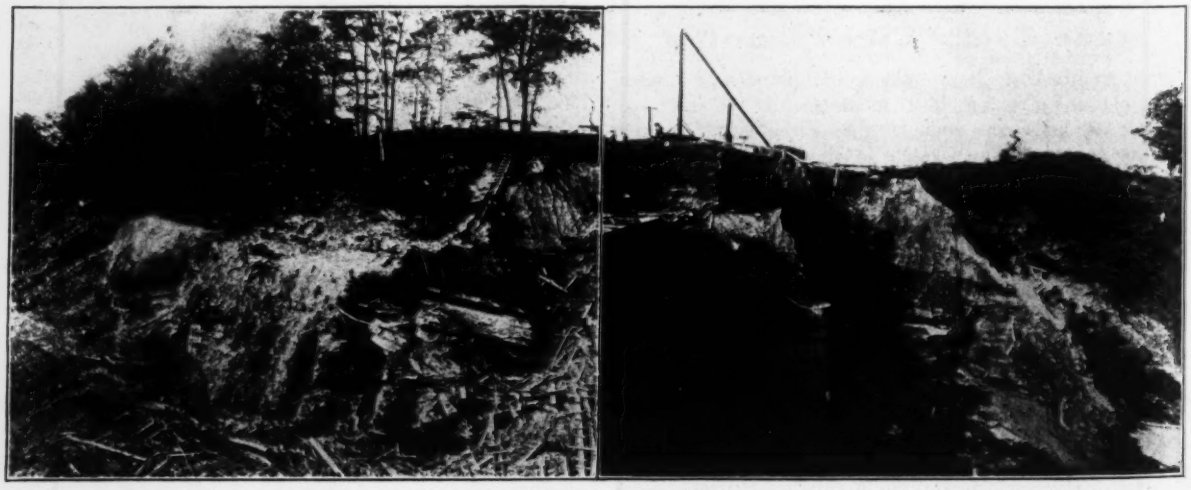
Repair of Break Around Seneca Falls Dam

In *Engineering News*, Sept. 16, 1915, p. 571, there was described the development of a break around the end of dam No. 2 on the Cayuga and Seneca Canal, near the town of Seneca Falls, N. Y. The conditions surrounding the break were unusual; and the work of repair, which has just been completed, was interesting.

It will be recalled that here are placed two locks of the New York State Barge Canal, each having a lift of 21½ ft. A 4-mi. level is maintained by a dam 475 ft. long, made up of an earth-fill section on the south end, a pair of twin locks in the center and a solid concrete section at the north end. The break occurred at the north end and was caused by the development of a semi-circular channel around and beyond the cutoff wall, which was carried 50 ft. into a bank of shale rock. It was found that the blowout tunnel was from 6 to 15 ft. in diameter and 120 ft. long. No damage was done other than caving of the bank at the outlet, where 10,000 cu.yd. washed out into the river below.

The repair consisted of cutting out the soft rock in the blowout tunnel and filling with concrete. Also, it was determined to carry the cutoff wall about 100 ft. farther into the hill. A deep trench was excavated on the surface to an elevation 8 ft. below the top of the dam, where a medium-hard limestone was encountered, except for a couple of broad cracks that went down from 15 to 18 ft. and also just beyond the end of the old cutoff wall, where the rock was poor all the way down to the blowout tunnel. After the tunnel had been driven a short distance a fault in the rock was disclosed, the line crossing the tunnel at a small angle. This fault explains the loose rock and probably was the cause of the blowout.

As shown in Fig. 4, in excavating below the blowout tunnel one short and one extended stratum of soft rock were encountered. The little one, hardly more than a finger, was excavated and entirely filled with concrete. A course for the core-wall extension was tunneled into the hillside through the soft material. To remove the poor rock and for convenience in placing concrete, a shaft was sunk at the end of the old cutoff wall. Five-inch drill holes were put down, as shown in Fig. 4, and the tunnel was



FIGS. 1 AND 2. ENTRANCE AND OUTLET OF BLOWOUT TUNNEL AT SENECA FALLS

FIG. 3. CAYUGA AND SENECA DAM NO. 2, AFTER REPAIRING BREAK OF SEPT. 3, 1915

filled with concrete from above through them. Bulkheads were built across the tunnel to enable concreting in sections. The shaft was concreted up to the level of the dam. For the tunnel, shaft and adjacent part of the blowout, a 1:2½:5 mix was used. The vent of the blowout was filled with 1:4:8. A retaining wall was

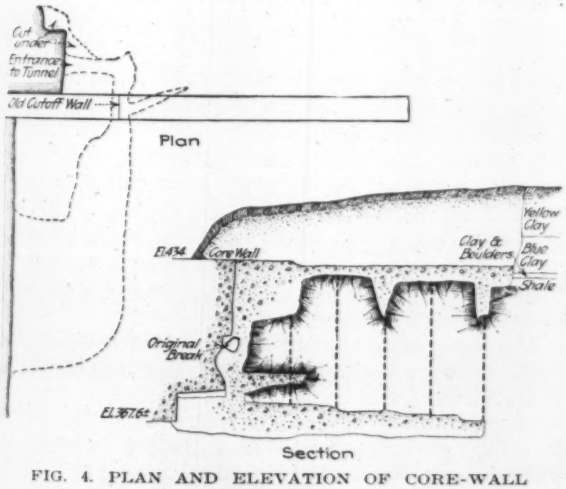


FIG. 4. PLAN AND ELEVATION OF CORE-WALL EXTENSION

placed where the outlet of the blowout tunnel had been and where the bank had caved. For 14 ft. the backfill was finished level with the top of the wall and then sloped up 1 on 1½. Some 3,000 cu.yd. of concrete was used in making the repairs around the dam.

Opportunity has been taken in connection with repairing the break to construct a concrete scouring apron and pave the spillway channel immediately beyond this apron with riprap, although this work is not in any way concerned with the repair of the break. The work was all completed and the reservoir filled Feb. 12, 1916.

Compression Test for Bronze; New York Central R.R.

In its specifications for phosphor bronze and other bearing metals required in movable bridges, turntables, etc., the New York Central R.R. (Lines West) is using a compression test. Compressive strength and the ability to stand a certain specified load without cracking are the most important requirements. A Brinell hardness test is also required, and minimum and maximum hardness members are fixed for certain metals. Little is specified concerning the chemical composition. The specification is as follows:

METALS FOR LININGS

Linings shall be made of alloys as specified herein. The linings shall be fine grained and of uniform structure throughout, free from gas cavities, oxidized metal and any segregation of metal. In making the alloys the best foundry practice shall be pursued. It is recognized that the requisite qualities are not alone shown by the chemical composition and physical properties. A chemical test and a physical test of each heat shall be furnished.

Test Coupon—The coupon for physical-test specimen shall be poured and treated in a way so that it will be truly representative of the casting.

Compression Specimen—The compression-test specimen shall be a finished cylinder 1 in. high and of 1-sq.in. cross-sectional area. This cylinder shall bear a 100,000-lb. load

without cracking. The elastic limit is the load which gives a permanent set of 0.001 in.

Hardness Test—Metal for linings shall be tested for hardness by the Brinell method. The ball shall be of hardened steel, 10 mm. in diameter. A load of 500 kg. shall be applied for 30 sec. to a finished plane surface of the casting or the untested specimen. See "Transactions" of the American Institute of Metals, Vol. 8, pp. 152 to 157.

At least two tests shall be made of each heat. In trunnion linings a test shall be made for each bearing. A record of tests shall be furnished.

Phosphor Bronze—Phosphor bronze shall be used for high pressure and slow speed.

Phosphor bronze shall be a copper-tin alloy, phosphorus not to exceed 1%. Other ingredients not above one-half of 1% will be allowed, except that no sulphur will be allowed. The phosphorus shall be introduced in the form of phosphor-tin alloy.

Phosphor shall have the following physical qualities, as determined on the cylindrical specimen under compression:

For sliding on soft steel: Elastic limit in pounds per square inch, 19,000 to 23,000; permanent set in inches under 100,000 lb., 0.12 to 0.20. For sliding on hardened steel: Elastic limit in pounds per square inch, 25,000 to 32,000; permanent set in inches under 100,000 lb., 0.07 to 0.10.

A hardness test shall be made.

Bronze for Bearings—Bronze for machinery bearings shall be a copper-tin alloy, with tin from 10 to 12%. Sulphur will not be allowed. Zinc up to 2% may be used. Other ingredients up to one-half of 1% will be allowed. Bronze for bearings shall have a hardness not less than 60 nor greater than 70.

Bronze for Wheels—Bronze for nuts and toothed wheels shall have about the same chemical composition as for bearings. It shall have the following physical qualities: Minimum ultimate tensile strength, 32,000 lb. per sq.in.; ultimate elongation in 2 in., minimum 0.10%, maximum 16%.

The bronze shall be tough and free from brittleness.

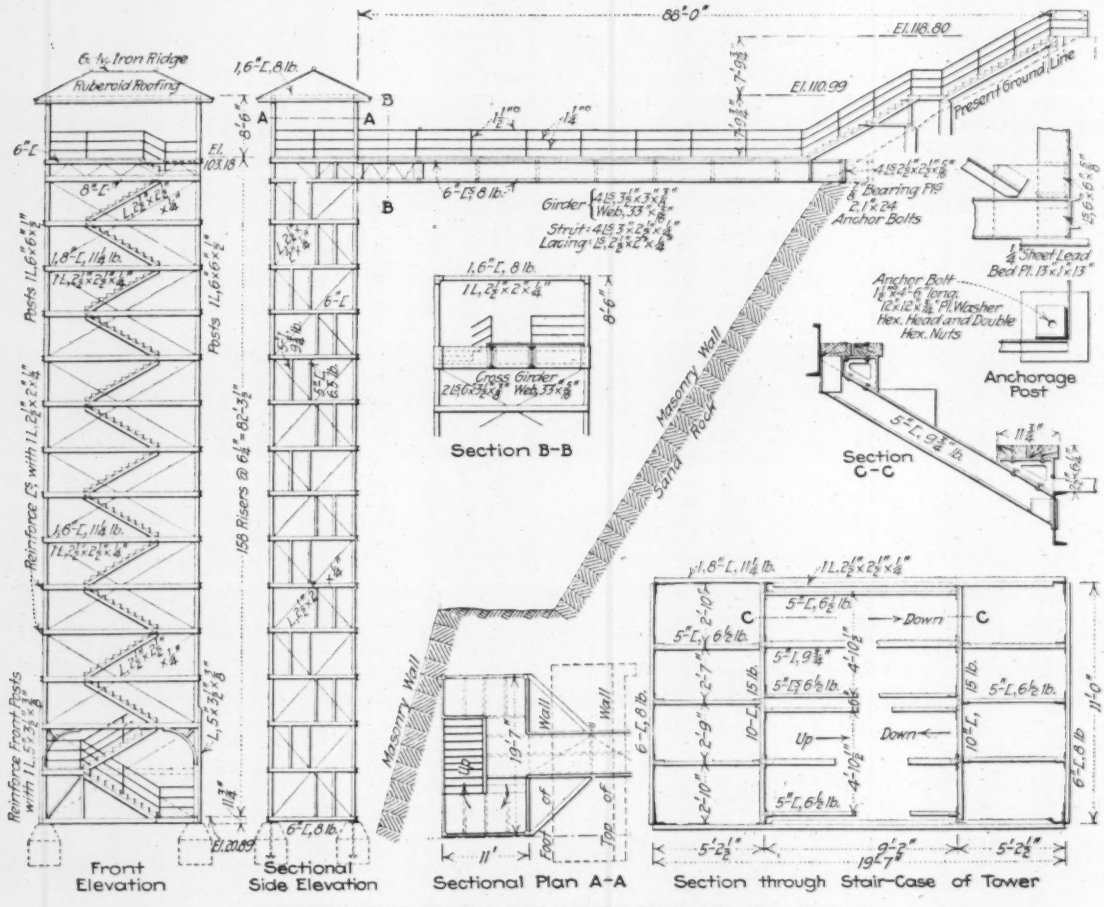
Babbitt Metal shall be a copper-tin-antimony alloy. Its hardness shall not be less than 25 nor greater than 32.

Steel Stair Tower for Bluff

The City of St. Paul is about to build a steel stair tower on the line of Hall Ave. to connect South Wabasha St. and Prospect Terrace across the gap made by the Mississippi River bluff. Most of the bluff is of the soft St. Peter sandstone.

The structure (see drawing) is exceedingly simple, consisting of four posts, channel girts and single-angle diagonal bracing. The posts are single 6x6x½-in. angles. The stairs are in reverse flights connected by landings whose beams support the stair stringers.

The tower is open in its full height, and the stairs are provided with railings on both edges. At the top a plate-girder bridge of 60-ft. span connects the tower with a point near the top of the bluff, whence a stairway of two flights leads to the top.



STEEL STAIR TOWER FOR SOUTH WABASHA ST., ST. PAUL

The tower frame is designed for a load of 50 lb. per sq.ft. on stairs, landings, etc. The platforms and stair stringers are designed for 100 lb. per sq.ft. The top landing, which by means of a transverse girder carries the bridge girders, is proportioned for 150 lb. per sq.ft. The wind pressure is taken at 30 lb. per sq.ft.

There is 10,000 ft. B.M. lumber in the structure and the weight of metal is 53,000 lb. The contract has been let to the St. Paul Foundry Co. for $3,900.

The structure was designed by M. S. Grytbak, bridge engineer, under O. Claussen, Chief Engineer, Department of Public Works, St. Paul.

Origin of the Southern Pacific Taper-Curve System

By William Hood*

In *Engineering News* of Sept. 16, 1915, there was published a review of a book on "The Railroad Taper," by Lee Perkins; and the reviewer raised the question why the 30-ft. chord length was originally adopted in the system of spiral curves developed by the writer, instead of some even fraction of 100 ft.

In answer to this question I would say that the transition, or spiral, curve of the form which I devised and tabulated in the spring of 1881 had a basic chord length of 30 ft.; and I applied to it at that time the word "taper," because it was one word and a short word and approximately descriptive of the compound curve.

The reasons for the selection of a 30-ft. chord length instead of using a quarter, a half, a third or other even fractions of 100 ft. were that the rails we were using were mostly 30 ft. long, with short rails between 26 and 30 ft. In curving rails in advance of track laying, with a 30-ft. chord length, a point on a curved rail need never be located more than 15 ft. from its theoretically perfect position. For convenience of measuring deflection, tenths of 100 ft.—for instance, three-tenths of 100 ft.—give in general more readily handled total curvature and deflections than a quarter or a third of 100 ft.

Probably any form of transition curve is good enough after a road is once constructed, if it is correctly maintained in the track. An important consideration in the selection of these curves, however, is facility and economy of field and office work in construction. Avoiding field computations of a character to delay the work of an expensive locating party or of construction is important. A locating party, with its field office and with its expensive water- and supply-hauling outfit, will often cost $100 a day in a desert mountain country. Lost time in a field computation therefore must be applied to the entire daily cost of the organization. For these reasons the form of taper tabulations mentioned, with the tables pasted into the front and back of the transit books, was found to give the best economy.

The tapers, changing as follows, will be found to meet practically all conditions for new railroad construction: Changing rate of curve with each 30 ft.—15′, 30′, 60′, 150′. For relocating track originally laid with plain curves, to introduce tapers, a greater variety is expedient to obtain economy in minimum track shifting.

Concerning the relation of the speed of the train to the length and number of the taper curve selected, it may be said that it is always best to select the longest and flattest taper that is financially practicable, regardless of the speed of the train. If the most desirable taper will cost too much money, then get along with a less desirable taper, bearing in mind that railroad trains of high speed are operated on lines laid without any taper curves and particularly bearing in mind that, when a train or any part of a train is once on the main curve, the taper has no more effect; and further, that it is no more appropriate to run beyond a proper speed on a tapered main-line curve than to run at the same speed on a curve of the same degree that is not tapered.

I presented a paper before the International Engineering Congress last fall, entitled "The Locating of a New Railway Line," and the following extracts give some further suggestions relative to the economical use of tapered curves:

The usefulness of the taper depends on the general maximum running speed of the trains in the several localities; and where speed restrictions result in slow speeds, as for instance either up or down steep mountain grades, the taper is not needed to a very great extent. In such localities a very short taper is justifiable, if it will save cost of construction as compared with a longer taper.

On valley lines a taper beginning with 30 ft. of a 15° curve leaves nothing to be desired for the use of the fastest trains. On mountain side and similar lines with steep grades and moderate grades a taper beginning with a 2° 30′ curve is found excellent in its results and is justifiably used where a flatter (and longer) taper would involve increased cost of construction.

Too flat a taper and too long a reversing tangent increase cost of construction in a mountain country with steep transverse slopes or in a confined river gorge where flood water is dangerous and where the mountain sides are steep, to an extent not always fully appreciated.

The effect of the taper and reversing tangent in increasing cost of construction is indicated by the resulting distances in a direct line between the centers of the corresponding main curves, as compared with the sum of the main curve radii, the difference of these distances indicating the horizontal distance to be disposed of in excess of the absence of horizontal distance required by reversed curves without tapers and without reversing tangents.

The greatest effect of this sort results from the use of flatter tapers, indicating more benefit with the same expenditure in construction from longer reversing tangents than from flatter tapers.

In illustration, two 6° curves with tapers commencing with 30 ft. of 1° curve and with 120 ft. reversing tangent will have their centers separated by a distance of 21.7 ft. in excess of the sum of their radii; and two 6° curves with tapers commencing with 30 ft. of 30′ curve and with 120 ft. reversing tangent will have their centers separated by a distance of 63.1 ft. in excess of the sum of their radii, resulting in the latter case in a distance of 41.4 ft. horizontal to dispose of in the last example in excess of that in the first example, which 41.4 ft. might result in prohibitive or at least in extravagant cost of construction.

These extra horizontal distances to dispose of, for instance in a river gorge, would mean part or all of the distance more than otherwise necessary used in placing the center line of the railroad more into the river-flood exposure or more into the mountain sides in cutting or tunneling, and in close localities might give excessive cost of construction without increasing the suitable speed of trains for that locality—all of which indicates the need of conservatism in deciding on the financially appropriate taper-curve rate.

*Chief Engineer, Southern Pacific Co., Flood Building, San Francisco, Calif.

Activated Sludge Defined—The best definition of the activated-sludge process of sewage treatment which he has ever seen, said T. Chalkley Hatton, chief engineer of the Milwaukee Sewerage Commission, in a paper read before the Indiana Engineers' Society on Feb. 3, is the one given by William R. Copeland, chief chemist for the Milwaukee Sewerage Commission, and is as follows: "The sludge embodied in sewage and consisting of suspended organic solids, including those of a colloidal nature, when agitated with air for a sufficient period, assumes a flocculent appearance very similar to small pieces of sponge. Aërobic and facultative aërobic bacteria gather in these flocculi in immense numbers—from 12,000,000 to 14,000,000 per c.c.—some having been strained from the sewage and others developed by natural growth. Among the latter are species which possess the power to decompose organic matter, especially of an albuminoid or nitrogenous nature, setting the nitrogen free; and others, absorbing this nitrogen, convert it into nitrites and nitrates. These biological processes require time, air and favorable environment, such as suitable temperature, food supply and sufficient agitation to distribute them throughout all parts of the sewage." The activated-sludge process, Mr. Hatton points out, should not be confused with the kind of artificial aëration of sewage, attempted from time to time in the past, which made no use of the sludge, as an aid to oxidation. The new process, Mr. Hatton states, "preserves the aërobic bacteria by keeping the sludge, which is their natural food, in intimate contact with air at all times and keeps them supplied with fresh food from the raw sewage, throughout the whole body of which they are in intimate contact."

Drainage Engineering*

By John T. Stewart†

For the low regard with which engineering work is held in the agricultural community the engineer is to a certain extent responsible. He has not exerted himself to raise the standard of his profession or to enlighten the communities in regard to the value of securing competent men for improvement work. The agriculturist has considered all engineers of the same grade and classed them according to price per day. As a result much poor work has been done, and the agriculturist, not getting the results he anticipated, has grown to look upon the term engineer as synonymous with large expenditures and inefficient results.

The engineer is at fault also in not making it clear to his clients that his fees are not charged for looking through a telescope, but that the transit and level are only an incident to the work and that the fee is charged for the training and judgment which the engineer possesses and uses for the benefit of his client.

The engineer, particularly in the farm community, could well afford to give some education on the value of competent engineering services. In the states which were first to adopt improved methods of land drainage, engineers' offices have been developed which are making a specialty of this line of work and are receiving fees for it that are commensurate with fees in other lines of engineering.

Until the engineer can show conclusively to the agricultural community that his services are economical and are the means of saving money and increasing wealth, there will be little demand for such services in land improvement. Modern demand for improved lands that will reach their highest producing possibilities in a short time, the rapid advance of farm methods and the scientific management of such lands are rapidly bringing the agricultural communities up to the point where only first-class improvements will be acceptable and proper engineering services cheerfully paid for.

Value of Drainage and Land Improvement

Our land-improvement work has been carried on to a certain extent under a wrong impression. When any improvement that has a tendency to increase production is under consideration, everyone talks about special assessments, additional taxes, etc. This is not the light in which such improvement should be considered, unless we want to hold that the original purchase price of a tract of land is a tax or special assessment. If landowners could be induced to see the final results and gains, it would cause a change in opinion as to the value of engineering services.

The whole tendency in drainage engineering at the present time is for the use of better materials, permanent construction and increased efficiency. To accomplish this result, reputable engineers are being called on to make designs and review plans without regard merely to the actual fee per day that will be charged for such services. The cheap, inadequate construction of days past is rapidly disappearing, although it will be continued in the newly developed areas for some time, and there is still room for educational work.

The general aversion of the landowner to an unsightly ditch across his fields is causing the small open ditch to be replaced by underground conduits. This construction results in a demand for increased sizes of tile, oftentimes at an expense that from an economic standpoint would hardly seem justifiable. The design and construction of such drains, to get them efficient without being unduly expensive, call for engineering skill far in advance of that required 20 years ago, when a 12- or a 15-in. tile was the "big drain."

The making of tile of large diameter without taking into consideration the load to be carried has led to many failures. The trouble became so great that the tile factories and tile contractors almost demanded that methods and specifications be prepared by which drain tile could be tested and classified like other construction materials. The American Society for Testing Materials appointed a committee in 1912 to prepare specifications for methods of testing drain tile. Its work is not yet completed, although several tentative reports have been made.

Segment Blocks for Drains

There is a limit to the size of clay or cement pipe that can be built in a factory, transported and laid in a trench. Apparently we were near the limit of the size of conduit for drainage work, when the segment block appeared. It was readily made, easily transported and laid; and the claim was made that it had the strength to carry the required loads. It is rapidly coming into general use throughout the Middle West for sewer work and is the coming material for drainage work for conduits above 30 in. in diameter.

While the form of the first blocks was patented, other forms are coming on the market. The cement men will probably furnish a similar block, and the competition will be sufficient to prevent a monopoly of any one patent.

It has been common practice to decide on the location of a ditch, determine its bottom width, give it 1:1 slopes and proceed to construct. In many instances the area of the watershed has been entirely neglected. No consideration has been given to the effect of this construction on the stream or channel into which it discharges and no provision made for change of grade in the channel or for the inlet of surface water from either side. Road ditches whose bottom elevation is 3 or 4 ft. above that of the main channel are left just as the dredge finds them. Breaks are made in the spoil banks, through which dead furrows and open channels lead. If no break is made, water piles up behind the spoil bank and works its way to the nearest road ditch and then comes into the main channel with a rush, carrying dirt and débris.

In many cases a ditch would be run practically level; then the grade would change to 1% and then again to 0.1%. The changes were made for economy in construction, to prevent deep cutting and still hold to a required depth. There was a time when irrigation ditches were constructed along the same lines, but it has been found economical where there is a rapid change of grade to make the change short and to place at that point a drop, or permanent structure for lowering the water. There are many localities on drainage districts where the change of grade could be made more economically by a permanent drop than by alternately changing from flat to high grades. It has been found economical to line irrigation channels around sharp curves or through soil that erodes easily.

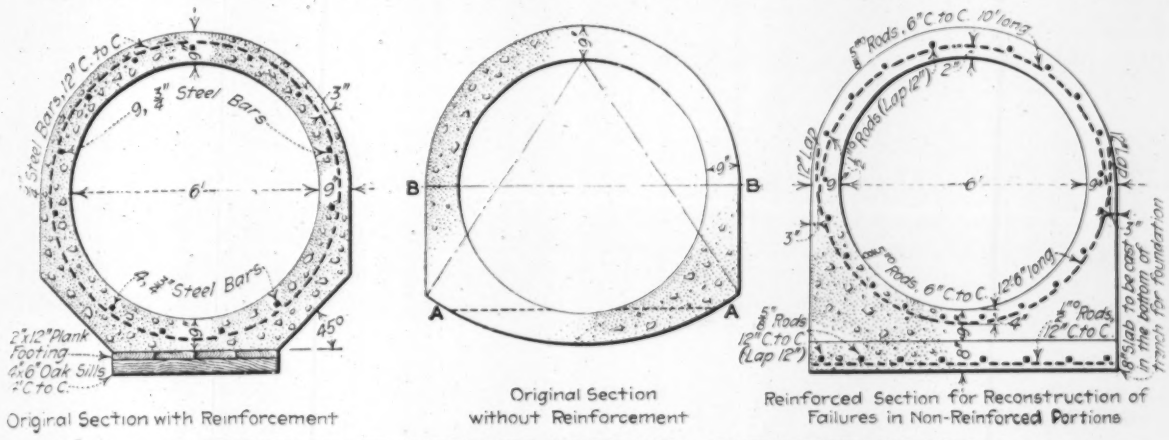
*Extracts from a paper read at the annual meeting of the Minnesota Surveyors and Engineers Society, St. Paul, Minn., Feb. 11.

†Chief of the Division of Agricultural Engineering, University of Minnesota, St. Paul, Minn.

and this practice will apply also to drainage channels. Steel piling and concrete walls are being used in levees and irrigation ditches, and the time is rapidly coming when they will be used in drainage work.

Failures in a 6-Ft. Concrete Sewer at Cairo, Ill.

Failures, or breaks, in a 6-ft. concrete main sewer have caused trouble at Cairo, Ill. One of the most serious of these failures occurred in December, 1915. The Commercial Ave. sewer leads to a pumping station where, at periods of high water in the river, the sewage is raised and discharged. The heavy pumping results in an external pressure on the sewer (with suction at any cracks). All the failures have been in parts of the sewer built without steel reinforcement. As a result of this experience all the newer and the repaired parts of this main sewer are of reinforced concrete. The original sections and the section used in reconstruction are shown in the accompanying drawing. The information was furnished by George F. Dewey, city engineer.



SECTIONS OF 6-FT. MAIN SEWER AT CAIRO, ILL., PARTS OF WHICH FAILED

Failures occurred in the section without reinforcement

While other parts of the sewer were still under construction, two breaks occurred in Commercial Ave. in 1909—150 ft. at 14th St. and 100 ft. at 15th St. They were repaired by the contractor, using the original section. Two breaks occurred in March and April, 1912—250 ft. at 14th St. and 175 ft. at 13th St. These were rebuilt by the city, using reinforced concrete; and the cost (less the reinforcement) was recovered from the contractor, as his guarantee did not expire until August, 1912.

In the spring of 1915 an examination showed that for 45 ft. south of the 13th St. break of 1912 the plain concrete sewer was shattered all over, but still holding in place. Excavation was started, in the expectation that by July the river would be low enough to permit the completion of the work, but the river reached a working stage for only three weeks during the remainder of the year. Pumping was done repeatedly, the water passing through the defective part of the sewer.

On Dec. 24, while pumping was in progress owing to the heavy rise in the rivers, this part of the sewer collapsed (between 12th and 13th St.); and considerable earth caved in before the damaged part could be shut off by bulkheads. They were placed at 11th and 13th St., after which pumping was resumed to relieve the sewers in other parts of the city. This break was in the largest section of the main concrete sewer and only 1,000 ft. from the main-sewer outlet and pumping station at 10th and Ohio St., near the river.

The bulkheads consisted of expanding circles placed across the sewer and wedged tight. The side next to the break was sheathed with 2-in. plank and covered with two courses of canvas, after which sacks of manure were placed against the bulkhead to the full height of the sewer, backed up by sacks of dirt. This formed an effective stop. The bulkheads were placed so that the pumping station at 10th St. could handle the flow from all sewers south of the break, while the other parts of the city were handled by the 28th and 38th St. pumping plants.

The flow line of the sewer at the break was 19 ft. below the surface of the paved street; bottom of concrete, 8 in. lower. The fracture, while originally 45 ft. long, has extended to about 125 ft. The effect of the settlement of the material immediately around the sewer is shown at the surface for a distance of 25 ft. east of the sewer line and 35 ft. on the west side. Loose earth and sacks of earth were placed in the cavity to offset the tendency of material to slough in from the sides, so as not to endanger the foundation of a building on the west side of the street.

The unreinforced part was built in 40-ft. sections. The base was poured first, up to line *AA*. Then the invert form was set on this; and the sides were poured up to *BB*, after which the arch was poured. Each section took its initial set before the next was applied. There were no dowels or reinforcing to connect these parts or to connect the 40-ft. lengths. The flow line is 18 to 19½ ft. below the street. A clay stratum extends down to the springing, below which is coarse and fine sand only, with some quicksand.

Mr. Dewey states that there would have been no difficulty in handling the water, but that there was 4.2 in. of rainfall in 48 hr., besides other lighter falls and the seepage water. In addition, there were 5,000,000 gal. pumped for the water company and 2,500,000 gal. pumped by the traction company from the Ohio River for condensing purposes, this water going back to the sewers. Fortunately, the low areas were able to hold this excessive rainfall, and only a few basements were flooded.

Engineering Literature

Military Reading Course for Civilian Engineers

On account of the widespread interest in the lectures on military engineering now being delivered at New York City under the auspices of the national engineering societies and because of the desire of many engineers throughout the country to inform themselves on military art and science, the short reading list appended to an editorial note in *Engineering News* of March 9, 1916, p. 473, is here followed by a list of sufficient length to meet the wants of the most zealous civilian advocate of preparedness.

The brief list already given was largely based on one prepared by the Chief of Engineers, United States Army, in response to frequent requests. The few books mentioned in that list will afford a convenient start in the more extensive reading course recommended by the Chief of Engineers.

He states that these references have been selected, first, with a view to giving to engineers a general survey of the art of war—an understanding of which is essential to the application of engineering knowledge to military purposes—and second, to set forth the ways in which engineering is applied. Military art and engineering are progressive, and a considerable part of the latest information is available only in the army service journals. This is particularly true of technical details of seacoast defense, field artillery, military aviation and their influence on military engineering. It is believed, however, that the fundamentals of each subject are well covered by the references given in this list. The books marked with an asterisk are those already mentioned as the first to be read.

ON MILITARY POLICY, CONDUCT OF WAR AND HISTORY

Group 1

1. Official Bulletin, Vol. I, No. 2—Office of the Chief of Staff, Washington, D. C. (Especially pp. 21-39.) Army War College, Washington, D. C.; free. (An official outline of the theory under which our forces are to be organized and administered.)

2. Military Policy of the United States—Upton. Superintendent of Documents, Government Printing Office, Washington, D. C.; paper, 50c.; cloth, 65c. (A most valuable and comprehensive review of this subject.

*3. Field Service Regulations, 1914—Superintendent of Documents; 60c. (A condensed official statement of principles, methods and details of military operations.)

*4. Elements of Strategy—Fiebeger. United States Military Academy; Book Department, Army Service Schools, Fort Leavenworth, Kan.; 75c. (A short outline, with historical illustrations.)

Group 2

5. Conduct of War—Von der Goltz; translated by J. Dickman. Hudson Publishing Co., Kansas City, Mo. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $1.70. (The standard work on this subject, covering generally the same ground as 4, but more abstractly and elaborately.)

6. On War—Clausewitz; translated by J. J. Graham; 3 vols. K. Paul, Trench, Trubner & Co., 1908. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $6.60. (The greatest classic on the subject; a complete analysis of the phenomenon of war and profound discussion of the mechanism thereof. Written early in the nineteenth century, it is still the foundation of modern military theory.)

7. American Campaigns—M. F. Steele; 2 vols. Byron S. Adams Publishing Co., Washington, D. C. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $4.50. (In addition to careful historical surveys of all the campaigns from the Colonial Wars to the Spanish-American War, these lectures give extensive and valuable comments as to the military principles.)

8. A Study of Attacks on Fortified Harbors—Rodgers. Proceedings Nos. 111, 112 and 113, United States Naval Institute, Annapolis, Md.

9. Lessons of the War with Spain—Mahan. Little, Brown & Co., Boston, Mass. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $2. (Of special importance, as showing the true relation between our coast defense and our navy.)

10. Reports of Military Observers on the Russo-Japanese War. Part III—J. E. Kuhn. Superintendent of Documents, Washington, D. C.; 60c. (In addition to an account of operations, this report contains valuable information as to fortification and siege work, organization and equipment.)

11. Organization and Operation of the Lines of Communications in War—Furse, 1894. William Clowes & Sons, Ltd., London. (An old but comprehensive survey of this subject, with much historical information.)

ON PERMANENT FORTIFICATIONS

Group 1

12. Report of National Coast Defense (Taft) Board, 1906. Army War College, Washington, D. C.; free. (The official project for harbor defenses of the United States. On account of progressive obsolescence of seacoast defenses this project has been or is being modified, but still sets forth clearly the fundamentals of its subject.)

Group 2

13. Lectures on Seacoast Defense—Winslow. United States Engineer School, Washington Barracks, D. C.; 50c. (Much of these lectures relates to technical details, and a considerable part is now obsolete.)

14. Permanent Fortifications—Fiebeger, 1900. United States Military Academy, West Point, N. Y. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $1. (While rather old, this work gives a simple presentation of the fundamentals on its subject, including a historical outline. A revised edition will soon be published.)

15. Fortification—C. S. Clarke. Dutton & Co., New York. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $4.50. (A treatise on the same lines as 14.)

16. Principles of Land Defense—Thuillier, 1902. Longmans, Green & Co. Book Department, Army Service Schools, Leavenworth, Kan.; $3.83. (A very valuable work, covering the principles of both field and permanent fortification.)

ON ORGANIZATION, EQUIPMENT AND DUTIES OF ENGINEER TROOPS

Group 1

*17. Field Service Regulations, 1914. (See 3.)

18. Tables of Organization, 1914—United States Army. Superintendent of Documents, Washington, D. C.; 25c. (These tables represent—subject to modification and within the limits of existing law—the approved policy of the War Department with regard to organization.)

19. Official Bulletin, Office of Chief of Staff, United States Army; Vol. I, No. 4 (Appendix 4), Use of Engineer Troops—Army War College, Washington, D. C.; free. (An official statement of the principles which should govern in the use of engineers, with practical suggestions.)

20. Duties of Engineer Troops in a General Engagement of a Mixed Force—Burgess. United States Engineer School, Washington Barracks, D. C.; 25c. (Obsolete in some respects, particularly organization, but excellent in general scope.)

21. General Orders No. 6—War Department, 1915. Adjutant General, United States Army, Washington, D. C.; free. (Prescribes the training of engineer troops.)

Group 2

*22. Studies in Minor Tactics—Army Service Schools, 1915. Book Department, Fort Leavenworth, Kan.; 50c. (The principles of minor tactics are set forth by solution of a series of problems.)

23. Technique of Modern Tactics—Bond & McDonough, 1914. Banta Publishing Co., Menasha, Wis. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $2.55. (This work covers, in a very specific way, the principles of tactics for all arms, a general knowledge of which is essential for engineers.)

24. Operation Orders—Von Kiesling; translation. Book Department, Army Service Schools, Fort Leavenworth, Kan.; 50c. (A lucid exposition, by use of assumed cases, of the operation of highly trained troops of all arms in various phases of battle.)

25. Engineer Unit Accountability Manual—Superintendent of Documents, Government Printing Office, Washington, D. C.; 5c. (Official lists of standard equipment supplied to engineer battalions and companies.)

26. Organization of the Bridge Equipage of the United States Army, 1915. (Revised edition just going to press.) (Includes description of equipage and regulations for pontoon drill.)

27. Officers' Manual—Moss. Banta Publishing Co., Menasha, Wis. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $2.50. (Treats of routine duties of officers, customs of the service, army organization, etc.)

28. Manual for Courts Martial—Superintendent of Documents, Government Printing Office, Washington, D. C.; 50c.

ON FIELD ENGINEERING

(Military field engineering at the front differs from ordinary engineering work in the field in being generally simpler, of a rough-and-ready character and especially because of the limited equipment which can be taken along with the advance of an army and because of the necessity of working in strict subordination to the military situation. In the rear of the army, on the contrary, conditions are very similar to those

governing ordinary engineering operations, and civilian organization is suitable, subject to directions by the higher military staff. Little attempt is made in works on military field engineering to treat of general engineering methods.)

29. Field Fortification—Flebeger, 1913. J. Wiley & Sons, New York. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $1.90. (In addition to technical details this work gives valuable historical illustrations of the principles of this subject.)

30. Field Entrenchments, Spade Work for Riflemen—John Murray, London. Book Department, Army Service Schools, Fort Leavenworth, Kan.; 40c. (A very uptodate little work, especially on details.)

*31. Notes on Field Fortifications—Army Field Engineer School. Book Department, Army Service Schools, Fort Leavenworth, Kan.; 30c.

*32. Engineer Field Manual—Professional Paper No. 29, Corps of Engineers, United States Army; 3d edition, 1909. Superintendent of Documents, Washington, D. C.; $1. (A very complete official pocketbook for engineer officers in the field. Part I, Reconnoissance; Part II, Bridges; Part III, Roads; Part IV, Railroads; Part V, Field Fortification; Part VI, Animal Transportation. A new revision of the manual is contemplated, but will not be ready within a year. The portion of the manual relating to field fortification, being somewhat obsolete, should be considered in connection with either 30 or 31. The portion relating to railroads is largely superseded by 35.)

33. Notes on Bridges and Bridging—Spalding. Book Department, Army Service Schools, Fort Leavenworth, Kan. (A small pamphlet on military bridging.)

*34. Military Topography for Mobile Forces—Sherrill. 2d edition. Banta Publishing Co., Menasha, Wis., 1911. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $2.25. (Besides matter given in ordinary textbooks on surveying, this work gives in detail the special methods of sketching developed in the army for rapid military mapping.)

*35. Military Railroads—Connor; Professional Paper No. 32, Corps of Engineers, United States Army. Superintendent of Documents, Washington, D. C.; 50c. (Intended to cover general administration of existing railroads for military purposes and the handling of railroads by military personnel in the advanced sections where railroads cannot be operated by their regular civilian organizations or where new railroads are required in the immediate vicinity of the army. Revised edition soon to appear.)

36. Notes on Military Explosives—Weaver. J. Wiley & Sons, New York, 1912. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $2.20. (Elementary notes on this subject will be found in the Engineer Field Manual and other references cited. This work is more elaborate.)

MISCELLANEOUS WORKS

37. Regulations for the Army of the United States—Superintendent of Documents, Washington, D. C.; 50c.

38. The Volunteer Law, approved Apr. 25, 1914; Bulletin No. 17, War Department, 1914—Adjutant General, United States Army, Washington, D. C.; free.

39. General Orders No. 54, War Department, 1914—Adjutant General, United States Army, Washington, D. C.; free. (Covers examination of candidates for commissions as officers of volunteers.)

40. General Orders No. 50, War Department, 1915—Adjutant General, United States Army, Washington, D. C.; free. (Amends General Orders 54, 1914, as to examination of candidates for commissions in volunteer engineers.)

41. Treatise on Military Law—Davis. J. Wiley & Sons, New York. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $5.30.

42. Elements of Military Hygiene—Ashburne. New edition. Houghton, Mifflin & Co., Boston, 1915. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $1.30.

ARMY SERVICE PERIODICALS

43. Professional Memoirs, Corps of Engineers, United States Army, and Engineer Department at Large—Bimonthly (formerly quarterly). Engineer Press, Washington Barracks, D. C.; per year, $3.

44. The Royal Engineers' Journal—Royal Engineers' Institute, Chatham, England; monthly; per year, $4. (American agents, E. Steiger & Co., 49 Murray St., New York.)

45. Journal of the Military Service Institution—Bimonthly. The Institution, Governors Island, New York; per year, $3.

46. Journal of the United States Artillery—Bimonthly. Coast Artillery School Press, Fort Monroe, Va.; per year, $2.75.

47. Journal of the United States Cavalry Association—The Association, Fort Leavenworth, Kan.; per year, $2.50.

48. Infantry Journal—United States Infantry Association, Union Trust Building, Washington, D. C.; per year, $3.

49. Field Artillery Journal—United States Field Artillery Association, 601 Star Building, Washington, D. C.; per year, $3.

*50. Infantry Drill Regulations—Superintendent of Documents, Government Printing Office, Washington, D. C.; 60c.

*51. The Service of Coast Artillery—Hines and Ward. Goodenough & Woglam Co., 122 Nassau St., New York City; $3.50.

CORRESPONDENCE

Standard Sewage-Works Terms

Sir—The "Need of Standard Terms in Sewage-Disposal Work," brought out by John H. Gregory in your issue of Feb. 17, is a matter of interest to many sanitary engineers. When one man speaks of a rack and another speaks of the same device as a screen it is confusing to the layman, if not to the engineer.

With regard to screens the Germans distinguish between different types by the words *rechen* (rakes or racks), *sieben* (sieves), *separatorscheiben* (perforated plates), *abfischgitter* (band of links for raising floating material from the sewage), etc., which usually suggest the form or function of the article. In English the screens are usually classified indiscriminately as coarse or fine.

The writer favors the single term screenings for the product of such devices (certainly not rackings or gratings), as this product does not differ with the type of screen so much as with the character of the sewage; but regarding screens themselves, there should be some authorized terms to distinguish the several types, as has been referred to by Mr. Gregory.

There is a similar difference in the terms settling tank and sedimentation basin; dosing tank and dosing chamber; disinfection and sterilization; sand catcher, grit chamber and detritus tank; purification, treatment and disposal, etc., from which one might infer a difference in meaning or function, when none was intended.

As to the term Emscher tank (*Emscherbrunnen*), that has been the term in general use in Germany and was at first the one in common use here, although within the past few years this type of tank has in America been more frequently called after the inventor—Dr. Imhoff.

The suggestion to standardize such terms as those mentioned is a good one and might well be taken up by the Sanitary Engineering Section of the American Public Health Association and the Sanitary Section of the Boston Society of Civil Engineers—jointly, if possible—together with other terms connected with sanitary engineering, as suggested in the article referred to.

KENNETH ALLEN,
Engineer of Sewage Disposal, Board of Estimate.
Municipal Building, New York City, Feb. 18, 1916.

Titles for, and Indexes of, Engineering Articles

Sir—The writer, like other engineers, has had difficulty in locating articles in completed volumes of engineering periodicals with the aid of the usual index. This is particularly true of articles that have been read at the time of publication, some particular feature of which, rather than the title, has left a lasting impression on the reader's mind. Later, when endeavoring to locate the article, one naturally searches in the part of the index where that feature would properly be listed, but too often without success.

As an example: If in an article descriptive of a new railroad line various types of structures were illustrated and described and then indexed under the very general heading "The Fruitvale Extension of the A. B. C. Ry.," the chance of finding them would depend entirely upon the reader's memory. The more important technical journals have long since realized this fact and index articles under various headings, but improvements are still possible.

The great multitudes of journals with a comparatively small circulation pay very little attention to indexing, most of them being content to give simply an alphabetical title index of articles. This practice leaves the bound volumes of such papers practically useless, and as a result very few engineers go to the expense of having them bound. The value of a technical journal is measured by

the completeness of its volume index. If a volume is not worthy of a good index, it certainly is not worth having.

Accepting the fact that some editors will not prepare good indexes on account of the labor involved, a partial solution can be obtained by the careful selection of titles for articles. This means that sensational newspaper headlines are out of place in a technical journal and that the title should convey the main key-words of the article, such as the name, type and location of the work described. A title such as "The World's Longest Arch Span" may be very attractive at the time of publication; but five years hence, when the structure no longer ranks as such, this title in an index is entirely misleading, since it may call to mind an entirely different structure, whereas had the name of the structure been included in the title, no such misunderstanding would arise. If, however, editors wish to use titles and headlines to attract the reader much in the same manner as newspaper headlines, the subject should be properly indexed and cross-indexed in the volume index, to preserve its reference value.

In order that a reader may readily find the subject he is searching for, it seems reasonable that the various subjects should be indexed under the main classification heading or idea, which in turn is divided into the various subclasses or ideas. For example, instead of merely listing descriptions of various buildings under the heading "Buildings," they should be listed under materials and again under type, such as flat slab, beam and girder, etc. (this for concrete buildings).

The writer has never seen an index quite as elaborate in outline as the one here suggested; but since the technical journals claim to have as one of their aims the furnishing of aid to the engineer in solving his problems, it would not seem out of place for them to index their volumes with more exactness than is now the rule.

What has been said regarding indexes for technical magazines applies with equal force to engineering books, a great many of which are poorly indexed. Some excellent works are marred, their usefulness hampered and the sales materially reduced by an insufficient and poorly arranged index. ALBERT M. WOLF.

Chicago, Ill., Feb. 27, 1916.

Expert Dealer in Second-Hand Engineering Books

Sir—In *Engineering News* for Feb. 17 there appeared an article entitled "Expert Dealer in Second-Hand Engineering Books." By those in charge of technical departments of public libraries and of engineering books in large offices the outcome of the suggestion that some engineer enter this field will be watched with interest.

In public libraries I doubt if there would be a great field for the proposed idea. Such volumes as would be offered for sale would, by virtue of the fact that they are of no more use to the library, seem to be of no value to the engineer. I have today in storage stacks over 400 books that are either superseded by later editions or that have outlived their usefulness. However, among the books offered to the market from a public library there might be volumes of peculiar interest to some engineers.

While I say that books of the kind just named are practically the only ones offering themselves for a second-hand market, there are at times "overflow" books—duplicate copies bought to supply a demand for more than one copy of the publication, but no longer needed. These books are deadwood. The librarian would welcome a possible market for them.

The field for back numbers of technical periodicals might prove fertile ground for an engineer to work in, where the International Magazine Co. and Boston Book Co. are not felt.

In this city I hope to index the people who subscribe to engineering periodicals that we do not take or that the university library lacks and note who are willing either to lend copies of their periodicals to brother engineers unable to get them or, if possible, to have those who subscribe to the magazines found in the canvass deposit odd copies, or copies that they wish no longer, in this library.

In short, if the scheme works out, the library aims to serve as a "Where to Look Bureau" for technical periodicals in the city and a clearing house for such, if possible. KENNETH C. WALKER,

Head Department of Technology,
Free Public Library.

New Haven, Conn., Feb. 19, 1916.

REVIEWS AND NOTES

Irrigation Practice

REVIEWED BY H. B. MUCKLESTON*

IRRIGATION PRACTICE AND ENGINEERING: Vol. I, Use of Irrigation Water and Irrigation Practice; Vol. II, Conveyance of Water; Vol. III, Irrigation Structures and Distribution System—By B. A. Etcheverry, Head of the Department of Irrigation, University of California. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiii + 213; xviii + 364 and xv + 438; 77, 82 and 186 illustrations. $2, $3.50 and $4 net.

The author states in his preface that this work is intended to fill the needs of teachers and students in technical colleges and to serve as a work of reference for engineers and managers of irrigation projects. It is in three volumes, of which the first deals entirely with the use of water on the irrigated farm and the other two with the design and construction of the system that delivers the water to the farm.

In the preface to the first volume, the author says that the designing engineer should have some practical knowledge of the agricultural phase of the problem. That this is an important matter is shown by the many irrigation failures which can be traced to the lack of just such knowledge on the part of the designing engineer.

Volume I opens with a chapter on the relation of soil moisture and plant growth and their bearing on irrigation practice. The chapter treats of the forms in which soil moisture occurs, the optimum percentage and the wilting coefficient, of soil moisture before and after irrigation and the feeding zone of plant roots. Consideration is next given to the disposal of irrigation water by transpiration, soil evaporation, deep percolation and surface waste and to the water requirements for various crops.

The time and frequency of irrigation for different crops, as governed by the varying factors of character of soil, amount of natural precipitation, soil and water

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temperature and soil-moisture condition during the irrigating season, are then discussed. The author states that the irrigation season may have to be adjusted to the available supply of water. He might have said with equal force that the character of crops may have to be similarly adjusted.

That much overworked term, "the duty of water," is next taken up. The author gives, as a commonly used definition, the relation between the area of land served and the quantity of water used and follows this by stating how the term is qualified in practice, as gross or net, or as measured at some intermediate point, such as the heads of laterals. Except in certain states where the meaning is fixed by statute, the term "duty of water," unless qualified, has no definite meaning, and its use alone is sure to lead to confusion, if not worse. It is desirable that the words be used in one sense only and that new terms be found or invented for the others. The author missed an opportunity here.

The two chapters on the preparation of the land and distribution of water on the farm are the most valuable chapters in the volume, for however desirable it may be for the irrigator to have a knowledge of the subjects treated in the earlier chapters, he does not always see the necessity, whereas the actual application of water is something which he must learn; and usually he learns it by costly experience. The author handles this subject in much the same order as the farmer would have to do the work, beginning with the initial job of clearing the land and going on through the subjects of smoothing and leveling to the planning and construction of the farm distribution system and the various methods of applying the water. The author has drawn freely from the publications of the United States Department of Agriculture and the various state institutions and has supplemented this material by his own observations. There is a particularly good description of the method of water distribution by cement pipes—a method formerly peculiar to California, but which is now largely used in other states. The chapter contains well-selected illustrations and descriptions of the various farm-irrigation structures that may be required.

The volume concludes with a chapter on the selection and costs of small pumping plants. The relative merits and demerits of various pumps and motors are pointed out and advice given in weighing these for a decision. Some approximate prices, which may be used with caution in preliminary estimates, are given.

The material presented in this volume is largely a careful selection from the great mass of experimental data available. In most cases the source is given, so that those who wish to may follow the matter farther. The material is logically arranged, and the written matter is illuminated by a copious use of illustrations. The volume should be a valuable addition to the libraries of those who cannot afford the time or money necessary to read the larger and more voluminous works on the same subjects. As the book is designed as a work of reference, it would be improved by a more copious index.

Volume II is devoted to the design and construction of the conveying channels that bring the water to the farms, including flumes, pipes, siphons and tunnels. It opens with a chapter on the general features and investigations precedent to design, followed by a chapter dealing with the planning and location of the system. The hydraulics of design of canals, flumes, pipes, etc., are next considered. As usual in American texts, Kutter's formula for the flow in open channels is given to the practical exclusion of all others, and as a consequence there is the usual presentation of another new diagram for the solution of this complicated and cumbersome equation.

The silt problem, losses from canals and the design of canal sections are next taken up. The seventh chapter is a very complete presentation of the subject of canal linings and prevention of losses. Numerous examples are cited by description and illustration, and the question of methods and costs is very fully dealt with. This is a subject which most textbooks on irrigation seem to fight shy of or ignore, and this chapter is a refreshing change. The material presented is drawn from a wide range of examples covering all conditions.

Chapter 8 handles tunnels, retaining-wall canal sections and bench flumes. Chapter 9 deals with flumes and Chapter 10 with pipes and siphons. The latter, which is by far the longest chapter in the volume, is the only one in which design is treated from any other point of view than that of carrying capacity. In this chapter the design of pipes is handled from the hydrostatic point of view as well as the hydraulic.

Volume III treats of irrigation structures and distribution systems. The division between the second and third volumes is arbitrary, but not illogical; and if a division was necessary, the line chosen is probably as good as any. The volume begins with a long chapter on diverting weirs, followed by one on scouring sluices and other appurtenances and by a third on headgates and regulators. Spillways and escapes, sand and silt traps, cross-drainage works and grade-correction works are the next topics to be given attention.

Throughout the chapters on design the author makes little reference, except in Chapter 10, Vol. II, to the static or hydrostatic requirements. This may account for the nearly complete absence of any reference to the destructive action of frost on all structural work in northern climates and particularly so in irrigation structures.

A chapter of 26 pages is devoted to the design of distributary systems and methods or systems of operating. Emphasis is laid on the desirability of constructing the system complete to the boundary of the farm unit, the undesirability of utilizing natural channels as irrigating machinery and the paramount necessity of an adequate drainage system, either artificial or natural. In the second part of the chapter the various methods of operation are described, and the advantages and disadvantages of each are outlined. The chapter concludes with an excellent discussion of required carrying capacities in distribution systems, which contains some very pertinent suggestions based on practice.

The last part of this volume deals with check gates, lateral headgates and turnouts, bridges and culverts, special types of distributing systems, such as pipe, flume, etc., and a variety of devices that have been proposed for measuring irrigation water.

Most of the matter presented in Vol. II and Vol. III is a very careful and catholic selection from the best of modern irrigation practice. The author is to be specially complimented on the excellence of the illustrations and the wealth of references given for those who wish to pursue any subject farther. The works of other writers are freely cited, sometimes to disagree with them.

Reinforced-Concrete Formulas and Diagrams

REVIEWED BY LEON S. MOISSEIFF*

SIMPLIFIED REINFORCED-CONCRETE MATHEMATICS: Derivation of Simple, Universal Formulas and Application of Same to Beams, Columns and Arches with Nomographic Computing Device—By Melvin D. Casler, Assoc. M. Am. Soc. C. E. New York: D. Van Nostrand Co. Cloth; 5x8 in.; pp. vi + 66; illustrated. $1 net.

Since reinforced concrete has become widely used, the equations of flexure of beams generally established in engineering practice for this composite material have become a fruitful source for the derivation of tables and diagrams to facilitate the statical computations of these beams. It is not that, for instance, the formulas for the flexure of a rectangular beam, based on the now almost generally accepted assumption of straight-line distribution of stress in the concrete, present difficulty in computing the required values; on the contrary, they are quite simple. But observant students would soon notice that the inter-relation of values in the five equations covering most cases of the flexure of reinforced-concrete beams can be simplified with the aid of a coördinate system expressed in tables or in diagrams.

Thus the position of the neutral axis of a rectangular beam is a function of the reinforcing-steel ratio and the ratio of the coefficients of elasticity of the materials used. The steel ratio itself is, at the same time, a function of the unit stresses. This inter-relation of values, quite simple in itself, has set to work many an engineer and has produced a number of excellent tables and diagrams that serve well to shorten the labors of the designer.

The author adopts the generally used assumptions and in deriving the formulas separates the expressions containing a decimal coefficient denoted by x. This coefficient represents the ratio of the distance between the neutral axis and the steel in tension to the depth of the beam measured to the same reinforcing. The author thus obtains four expressions, all of which are functions of x as the only variable. He then computes the values of these four expressions for various values of x and tabulates them for ready use. By placing the corresponding values on one line, only one of the four has to be computed, and the others will be found on the same line.

The author then carries out the same idea graphically. He plots the values in four concentric circles, so that when any one of the values is given the others are found along a radial line.

The application of this method is well illustrated by nine examples covering most cases met in practice. The eighth problem illustrates a common case of a reinforced arch; and while it is theoretically correct, it brings out clearly the limitations of the author's graphic procedure in this instance. Due to the nature of arch action the tensile stress in the steel is the difference between the direct compressive stress and the tensile bending stress. It is well known to every engineer that the degree of accuracy required for values whose difference is used must generally be much higher than where their sum is to be obtained. In the example brought out in the book, on page 53, the area of steel required is computed at $a = 0.179$ for a value of $T = 0.165$. A slight difference in reading the plotted values, say $T = 0.166$, results in $a = 0.152$, or about 85% of the former value. Evidently this very common case is not suitable for the graphic procedure.

The author has succeeded in producing a neat little volume and has added to the labor-saving devices of the engineer, for which he deserves credit.

*Consulting Engineer, 69 Wall St., New York City.

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Wisconsin Utility Regulation

REGULATION OF RAILROADS AND PUBLIC UTILITIES IN WISCONSIN—By Fred L. Holmes. New York: D. Appleton & Co. Cloth; 6x9 in.; pp. xi + 375. $2 net.

By giving a clear account of the aims, methods and results of public-utility regulation in Wisconsin, Mr. Holmes has outlined what good control is, or might be, generally in this country. It is universally admitted that the Wisconsin Railroad Commission has done pioneer work in developing right principles and reasonable practice, but probably few persons know precisely what has been accomplished or how it has been done. Mr. Holmes' book draws back the curtain for all who have not had the time to go back of it themselves. The author is in an advantageous position to review broadly the work of the commission, having been for some time a member of the state legislature and chairman of the assembly transportation committee. The book shows evidence of the friendly coöperation of the commission's experts; there are numerous collections of data which could not have been presented otherwise. The book will be of service to everyone having a part in the regulation of utilities anywhere and to the officials and engineers of the public-service companies as well.

The book starts off with a summary of the development of the Wisconsin railroad and utility laws and the building up of the commission and its bureaus. Next are noted the need of plant valuations and the developed processes of appraisal. What the commission holds to be a fair rate of return—covering interest, risk, wages of management and profits—is explained, and data are given as to what has been allowed at various times. Emphasis is placed on good service and the development of definite standards for railroad, water, gas, electric, street-railway and telephone service is interestingly described. There is a short chapter telling how a scheme of uniform accounts was developed, upon a basis of summary double-entry bookkeeping, to show assets and liabilities, revenues and expenses and the disposal of profits and losses.

One chapter is devoted to "depreciation." This is not a clear presentation of the topic, for the author first defines depreciation as the amount set aside to cover impairment of capital and then uses the term also to describe the actual reductions in plant value. The author has also swallowed the now well-known bookkeeping trick of the Wisconsin commission—figuring annual depreciation-indemnity less than the actual loss of capital, making up the difference under guise of interest on too large physical value and asserting that thereby the cost of providing against depreciation has been reduced. The experience of the commission in building up and using life tables for utility property is the important contribution of this chapter.

In a chapter on "Making Railroad Rates" the author at first puts the Wisconsin commission down as definitely committed to cost-of-service, distinguished from value-of-service, as the basis and lauds the ability of its staff properly to apportion the joint costs and overhead expenses over the complicated services of a trunk railway.

Later on, however, the author cites decisions that show that the commission used cost-of-service figures as a basis of departure below which charges ought not to go and above which value-of-service controls.

The adjustment of water, gas and electricity rates on the famaliar output-demand-customer basis occupies one chapter. Much is said historically about electric-railway service and equipment, but no large amount is given on street-railway rates. These details of electricity and gas rates are given in a further chapter, and explanations are offered (lack of necessity and difficulty) of the failure, to date, to work out quite so completely a scheme of scientific telephone rates.

Under the chapter heading "Water Utilities" is a discussion of the need of control over municipal-service departments, which soon runs into water-works regulation. There is considerable on the differing requirements of city supply and fire protection, supplementary to the earlier chapter on actual formulation of water, gas and electricity rates.

The beauties of the indeterminate-permit type of franchise are set forth in one chapter, and in another, existing control over the issuing of securities is discussed. A chapter is filled in portraying the steps incident to putting water powers under the Railroad Commission.

What has been noted herein does not show the entire scope of this most comprehensive work. There is still left a quarter of the text, giving definite data on the improvements that have been wrought in railway service and safety, betterments forced on municipal utilities, the failure of municipal control contrasted with the success of state regulation, progress of investments under state utility supervision and support of the commission by courts.

Telephone Valuation

TELEPHONE APPRAISAL PRACTICE—By J. C. Slippy, author of "Telephone Cables" and "Appendix A. Telephone Construction-Methods and Costs." Pittsburgh, Penn. (428 Oliver Building): The Author. Cloth; 6x9 in.; pp. 97. $4.

It is a sign of engineering progress when new technical papers and books leave behind the general discussions of valuation—the many-times threshed "principles"—to present detailed methods and specific results in a limited field like telephony. Mr. Slippy's little book therefore will find a welcome in many an engineering library—partly because it gives specific procedure and data and partly because the telephone field is generally regarded a difficult one for an appraisal engineer.

The author's first few pages present certain definitions of fundamental terms for the orientation of the reader, who then is unceremoniously confronted with an outline of information that a commission usually needs in any telephone case—on general operation, plant value, finances. There are a few words upon the desirability of valuing on the basis of cost to reproduce and upon some of the incidental problems, like identical versus substitute plant, present versus original conditions, etc.

The work of making an inventory is developed by giving (1) a classification of fixed-capital accounts for a telephone utility, (2) blank forms for reporting plant items, (3) instructions about use of maps and forms, about desirable details, etc.

While the tabulation of unit costs is shown on the forms and their use is referred to in the pages so far mentioned, there is a whole chapter devoted to this matter. The labor and material costs of line construction in the Middle West are given separately and in detail.

A chapter is given up to "Depreciation," the author favoring the straight-line method—and apparently as a "repayment scheme," since depreciated value of physical property is cited as the final result.

Various life-data tables on telephone plant are compared. The final chapter reviews and summarizes the requirements of several commissions in telephone appraisal.

Analytical Mechanics

REVIEWED BY CLYDE T. MORRIS*

ANALYTICAL MECHANICS, for Students of Physics and Engineering—By H. M. Dadourian, Instructor of Physics in the Sheffield Scientific School of Yale University. Second edition, revised and enlarged. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. xiv + 431; 148 illustrations. $3 net.

As stated in the preface, this book is based on a course of lectures and recitations given by the author to the junior class in electrical engineering at the Sheffield Scientific School. It has been enlarged about 80 pages from the 1913 edition by the insertion of a chapter on framed structures and graphic statics and by the addition of many problems. Parts of Chapters VI, VII and XII. on motion, have been rewritten.

The subject is presented largely from the physicist's viewpoint, especially the part on motion, which occupies 8 of the 16 chapters. The book contains nothing on the mechanics of materials, and in general the treatment is not particularly new. The mathematics of the latter half of the book might have been simplified in some cases by a little more detailed explanation.

At the beginning of the book is given a "Table of Notations," which is very useful and which insures a uniform notation throughout the work. From this table the meaning of any character in an equation can be found. Illustrative examples completely worked out are distributed through the text, and problems are given at the end of each chapter. These are very good.

Railway Maintenance Described

MAINTENANCE OF WAY AND STRUCTURES—By William C. Willard, Assoc. M. Am. Soc. C. E., Assistant Professor of Railway Engineering, McGill University. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xxi + 451; 232 illustrations. $4 net.

Professor Willard's book is a useful addition to the rather limited literature on railway track and maintenance, although it follows largely on lines already covered. It is brought up to date, but goes rather outside its scope to deal with matters that have little relation to maintenance. The use of copious extracts from specifications and reports is hardly a commendable feature, as such matters can be and should be presented more effectively and much more concisely in a book of this kind.

The greater part is devoted to descriptions of equipment and appliances. The relatively small part on maintenance work treats mainly of ordinary routine details. Thus the matter on ditching refers to minor work done by hand and simply mentions the use of machines, without discussing the problems of handling ditching economically on lines of heavy traffic. Nor is

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there much information as to switchwork, sidings, terminal layouts, widening banks and cuts, renewing track in tunnels or the larger problems of maintenance work. Two special subjects not often discussed in technical books are taken up—namely, stresses in track and the design of track.

The index is so arranged as to waste considerable space, and although extensive, it is not systematic. For example, under "Bridge" there is no reference to "Inspection," "Maintenance" or "Painting," although these subjects are treated in the book. The 8-page detailed list of contents is a superfluity. The printing and illustrations are excellent.

Corrosion of Iron

REVIEWED BY FRANK B. SANBORN*

THE CORROSION OF IRON: A Summary of Causes and Preventive Measures—By L. C. Wilson. New York: The Engineering Magazine Co. [Works Management Library.] Cloth; 5x8 in.; pp. vi + 178. $2.

A book on the corrosion of iron is timely now that copper, brass and other noncorrosive metals are so high in price that engineers are utilizing iron as far as practicable. The book under review does not tell the engineer specifically when to use iron and when not to, but it will be a guide to him. It gives many facts about the rust problem—the causes of corrosion, protective measures that have been tried, the effects of ingredients of paints under many combinations to prevent rust, how to prepare or select the best paint for given conditions, the effect of the constituent elements of iron and of alloys in resisting rust and an analysis of the merits of wrought-iron and steel pipe.

The average engineer does not care to read an exhaustive treatise on these topics. He wants to get a quick insight into questions that should govern him in selecting proper materials. He looks for a short treatment alive with facts, clearly and concisely presented. He will find, the reviewer thinks, Mr. Wilson's brief treatise sufficiently comprehensive and technical, yet not intricate nor rambling.

Railway Rates and Regulation

RAILWAY REGULATION: An Analysis of the Underlying Problems in Railway Economics from the Standpoint of Government Regulation—By I. Leo Sharfman, Professor of Political Economy, University of Michigan. Chicago: La Salle Extension University. Flexible leather; 6x9 in.; pp. vi + 230. $2 postpaid.

Professor Sharfman's review of the railway rate and regulation situation is an admirable and concise presentation of a large subject, but necessarily is stripped of all but the most important details. The suppression of detail has accentuated the fundamental principles and outstanding features to be observed. Naturally and inevitably the result of trying to make such a book is essentially an epitome of the larger and older treatises, like Professor Ripley's "Railways: Rates and Regulations."

The author opens with familiar figures on the magnitude of the railway industry and with notes on its influence on the development of the nation. There is not much right here on the aggression of arrogant railway officials or on the growth of rank discrimination that led to popular demand for the proper suppression of utilities as public servants. But there are notes on the legal right to control (dealing with the public nature of the business) and the economic benefit (monopolistic nature of railways, self-destructive competition, chance for unfair influences, etc.). Having thus led up to the task and methods, the author drops back to present more in detail the history of railroading under private development and public aid, the evils of early speculation and the turn of public sentiment against the roads.

After a descriptive chapter on competition the "theory and practice of rate making" are taken up. Here "cost of service" and "value of service" theories are outlined, the desirability of using the one and the practical necessity of adopting the other showing up immediately. A few pages are given up to the classification of goods shipped and the adjustment of rates effected by the Interstate Commerce Commission.

In the rest of the book are traced the development in the courts of the right of the states to regulate roads and the gradual evolution of the powers of the Commission.

Making Ford Automobiles

REVIEWED BY ROSSITER R. POTTER*

FORD METHODS AND THE FORD SHOPS—By Horace Lucien Arnold and Fay Leone Faurote. New York: The Engineering Magazine Co. [Works Management Library.] Cloth; 7x10 in.; pp. x + 440; illustrated. $5.

The chapters of this book were published originally as a series of articles in the "Engineering Magazine." Collected here, they form a volume that must be of absorbing interest to almost anyone. By no means the least interesting is the first chapter, giving, among other things, Mr. Ford's personal history. Chapter II describes the Ford stock system and the employment methods. The remainder of the book takes up in detail different features of the production departments.

There are of course innumerable Ford innovations in automobile-manufacturing methods, which result more or less naturally from the truly stupendous output of more than 1,000 cars per day; but probably the most distinctive general feature of the production methods is the widespread use of conveyors, work-slides and rollways for moving materials in process of manufacture from one operation to the next. It is of interest to notice that there is clearly indicated the possibility of considerable further progress in reducing the cost of manufacture of the Ford car.

The book is well prepared and is freely illustrated, chiefly with excellent photographs. It all but leaves the reader with the impression that he has actually visited the Ford shops and studied them at first hand.

Much About Alloy Steels

MANUFACTURE AND USES OF ALLOY STEELS—By Henry D. Hibbard. Washington, D. C.: United States Bureau of Mines. Paper; 6x9 in.; pp. 72.

This most complete recent monograph on alloy steels should be in the hands of every structural and mechanical engineer. The author covers separately the various classes—simple tungsten, simple chromium, manganese, nickel, nickel-chromium, silicon, high-speed and chromium-vanadium. He gives figures of composition and properties, describes methods of production and discusses the chief uses, past as well as present.

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*Assistant Manager, Blood Brothers Machine Co., Allegan, Mich.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION: Proceedings of the Annual Convention Held at Detroit, Mich., Oct. 19-21, 1915—Chicago (319 North Waller Ave.): C. A. Lichty, Secretary. Paper; 6x9 in.; pp. 389; illustrated. $1.

ANNUAL REPORT OF THE DEPARTMENT OF THE INTERIOR OF CANADA FOR 1914: Part VIII, Report of the Superintendent of Water Powers—Ottawa, Canada: Dominion Water Power Branch. Paper; 7x10 in.; pp. 309; illustrated.

ANNUAL REPORT OF THE MISSISSIPPI RIVER COMMISSION FOR 1915: Extract from the Annual Report of the Chief of Engineers, United States Army, for 1915—Washington, D. C.: War Department. Paper; 6x9 in.; pp. 215; illustrated.

ANNUAL REPORT OF NEW YORK STATE ENGINEER AND SURVEYOR FOR 1914; Vol. II, Report on Hydraulic Data, Department of the Barge Canal, Comprising the Fifteenth Annual Report on Stream Gaging—Albany, N. Y. Cloth; 6x9 in.; pp. 367.

CITY AND TOWN PLANNING CONFERENCE OF MASSACHUSETTS PLANNING BOARDS: Third Annual Conference, Held at Boston, Nov. 12, 1915, with the Homestead Commission—Boston: Henry Sterling, Secretary of the Commission. Paper; 6x9 in.; pp. 40.

CITY PLANNING: A Series of Papers Presenting the Essential Elements of a City Plan—Edited by John Nolen, Fellow, American Society of Landscape Architects. New York: D. Appleton & Co. [National Municipal League Series.] Cloth; 5x8 in.; pp. xxvi + 447; illustrated. $2 net.

COAL AND COKE—By Frederick H. Wagner, M. Am. Soc. M. E., Gas Byproduct Lecturer in Johns Hopkins University. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xii + 431; 137 illustrations. $4 net.

THE COMMODITIES CLAUSE: A Treatise on the Development and Enactment of the Commodities Clause and Its Construction When Applied to Interstate Railroads Engaged in the Coal Industry—By Thomas Latimer Kibler, Professor of Economics, Agricultural and Mechanical College of Texas. Washington, D. C.: John Byrne & Co. Cloth; 6x9 in.; pp. 178. $3 delivered.

THE COMPRESSIBILITY OF NATURAL GAS AT HIGH PRESSURES—By G. A. Burrell and I. W. Robertson. Technical Paper 131. Washington, D. C.: Bureau of Mines. Paper; 6x9 in.; pp. 12.

THE DISPOSAL OF HUMAN EXCRETA AND SEWAGE OF THE COUNTRY HOME—By Theodore Horton, Director, Division of Sanitary Engineering. Albany, N. Y.: New York State Department of Health. Paper; 6x9 in.; pp. 18; illustrated.

ELEVATORS: A Practical Treatise on the Development and Design of Hand, Belt, Steam, Hydraulic and Electric Elevators—By John H. Jallings, Mechanical Engineer and Elevator Expert with Karstner & Hecht Co., Chicago. Chicago: American Technical Society. Cloth; 6x9 in.; pp. 217; 172 illustrations. $1.50.

FARM DRAINAGE IN NORTH DAKOTA—By H. M. Lynde, Senior Drainage Engineer, United States Department of Agriculture. Bulletin No. 234. West Raleigh, N. C.: North Carolina Agricultural Experiment Station, College of Agriculture and Mechanic Arts. Paper; 6x9 in.; pp. 32; illustrated.

GEODETIC SURVEYING—By Edward R. Cary, M. Am. Soc. C. E., Professor of Railroad Engineering and Geodesy, Rensselaer Polytechnic Institute. New York: John Wiley & Sons. Cloth; 5x8 in.; pp. ix + 279; 100 illustrations. $2.50 net.

HILFSTABELLEN ZUR BERECHNUNG VON WARMWASSERHEIZUNGEN—Herausgegeben von H. Recknagel, Diplom.-Ingenieur, Berlin-Schoeneberg. Munich and Berlin: R. Oldenbourg Verlag. Stiff paper; 10x13 in.; pp. 30. 4.50 marks.

HOUSE WIRING: A Treatise Describing and Illustrating Uptodate Methods of Installing Electric-Light Wiring, Bell Wiring and Burglar-Alarm Wiring—By Thomas W. Poppe, Electrical Engineer and Contractor. Second edition, revised and enlarged. New York: The Norman W. Henley Publishing Co. Linen; 4x6 in.; pp. 125; 95 illustrations. 50c.

INDUSTRIAL LEADERSHIP—By H. L. Gantt. [Addresses delivered in the Page Lecture Series, 1915, before the Senior Class of the Sheffield Scientific School, Yale University.] New Haven, Conn.: Yale University Press. Cloth; 5x8 in.; pp. xii + 128; 6 charts. $1 net, postpaid.

THE JOURNAL OF THE IRON AND STEEL INSTITUTE, Vol. XCII—Edited by George C. Lloyd, Secretary. London (28 Victoria St., S. W.): Offices of the Institute. New York: Spon & Chamberlain. Cloth; 6x9 in.; pp. 384; illustrated.

THE "MECHANICAL WORLD" ELECTRICAL POCKET BOOK FOR 1916: A Collection of Electrical Engineering Notes, Rules, Tables and Data—Manchester, England: Emmott & Co. Baltimore, Md.: The Norman, Remington Co. Cloth; 4x6 in.; pp. 240; 130 illustrations. 30c. postpaid.

THE NEW PUBLIC HEALTH—By Hibbert Winslow Hill, Director, Institute of Public Health, and Medical Officer of Health of London, Canada; Professor of Public Health, Western University. New York: The Macmillan Co. Cloth; 5x8 in.; pp. 206. $1.25.

THE OPERATION AND CARE OF SEWAGE-DISPOSAL PLANTS—Ames, Iowa: Engineering Extension Department, Iowa State College of Agriculture and Mechanic Arts. Bulletin No. 16. Paper; 6x9 in.; pp. 23; illustrated.

OXYACETYLENE WELDING AND CUTTING: Electric, Forge and Thermit Welding, Together with Related Methods and Materials Used in Metal Working and the Oxygen Process for Removal of Carbon—By Harold P. Manly, Chief Engineer, American Bureau of Engineering. Chicago: Frederick J. Drake & Co. Cloth, leather; 4x7 in.; pp. 215; 56 illustrations. Cloth, $1; leather, $1.50.

PRACTICAL PERSPECTIVE: A Treatise Showing Just How To Make All Kinds of Mechanical Drawings in the Only Practical Perspective (Isometric)—By Frank Richards and Fred H. Colvin. Fourth edition. New York: The Norman W. Henley Publishing Co. Linen; 4x7 in.; pp. 58; 64 illustrations. 50c.

PRICE-REGULATION UNDER PATENTS—By Joseph A. Minturn. Indianapolis, Ind. (833 Pythian Building): Minturn & Woerner. Paper; 6x9 in.; pp. 56. $1.

PRINCIPLES AND METHODS OF MUNICIPAL ADMINISTRATION—By William Bennett Munro, Professor of Municipal Government in Harvard University. Cloth; 6x9 in.; pp. xi + 491. $2.25 net.

PUBLICATIONS OF THE DEPARTMENT OF MINES OF CANADA—Ottawa, Canada. Paper; 7x10 in.; illustrated.
Description of the Laboratories of the Mines Branch of the Department of Mines. Bulletin No. 13. Pp. 51.
The Production of Cement, Lime, Clay Products, Stone and Other Structural Materials in Canada During 1914. Pp. 60.

RAILROAD VALUATION AND RATES—By Mark Wymond. Chicago (Rand-McNally Building): Wymond & Clark. Cloth; 5x8 in.; pp. 339; illustrated. $1.50.

REPORT OF THE BOARD OF ENGINEERS ON FLOOD CONTROL TO THE BOARD OF SUPERVISORS OF LOS ANGELES COUNTY, CALIFORNIA—Los Angeles, Calif.: Board of Supervisors. Paper; 8x11 in.; pp. 400; illustrated. Articles based on this report were published in "Engineering News" of Feb. 10 and 17, 1916.

REPORT ON MARKET SYSTEM FOR NEW YORK CITY AND ON OPEN MARKETS ESTABLISHED IN MANHATTAN—By Marcus M. Marks, President of the Borough of Manhattan and Chairman of the Committee on Markets, Board of Estimate and Apportionment. New York (Municipal Building): The Board. Paper; 7x10 in.; pp. 121; illustrated.

ROAD MATERIALS OF TEXAS—By James P. Nash, Testing Engineer. Bulletin No. 62. Austin, Tex.: Editor of University Publications, University of Texas. Paper; 6x9 in.; pp. 70; illustrated.

SEWERAGE: The Designing, Construction and Maintenance of Sewerage Systems—By A. Prescott Folwell, M. Am. Soc. C. E., Past-President, American Society of Municipal Improvements; Editor of "Municipal Journal and Engineer." Seventh edition, revised and enlarged. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. x + 540; 46 illustrations. $3 net.

SMOKE ABATEMENT—By C. H. Benjamin, Dean of the Schools of Engineering. Lafayette, Ind.: Engineering Department, Purdue University. Paper; 6x9 in.; pp. 12; illustrated.

SPECIAL ASSESSMENT SECURITIES—An Address by Arthur E. Morgan, M. Am. Soc. C. E., President of the Morgan Engineering Co. [Reprinted from the Proceedings of the Engineers' Club of Dayton.] Paper; 6x9 in.; pp. 16.

SPECIAL STUDIES IN ELECTROLYSIS MITIGATION: IV, A Preliminary Report on Electrolysis Mitigation in Elyria, Ohio, with Recommendations for Mitigation—By Burton McCollum, Electrical Engineer, and K. H. Logan, Assistant Physicist. Technologic Paper No. 55. Washington, D. C.: Bureau of Standards. Paper; 7x10 in.; pp. 49; illustrated.

STREAM POLLUTION AND SEWAGE DISPOSAL IN ILLINOIS WITH REFERENCE TO PUBLIC POLICY AND LEGISLATION—By LeRoy K. Sherman. Bulletin No. 16. Rivers and Lakes Commission of Illinois. Chicago (905 State Building): Charles Christmann, Secretary. Paper; 6x9 in.; pp. 32.

SUMMARY OF RAILWAY RETURNS FOR THE YEAR ENDING JUNE 30, 1915 (Compiled from Reports to the Interstate Commerce Commission)—Washington, D. C.: Bureau of Railway Economics. Consecutive No. 88. Paper; 6x9 in.; pp. 23.

A SURVEY OF THE ACTIVITIES OF MUNICIPAL HEALTH DEPARTMENTS IN THE UNITED STATES—By Franz Schneider, Jr., Sanitarian, Department of Surveys and Exhibits, Russell Sage Foundation. New York (105 East 22d St.): Survey Associates, Inc. [Reprinted from the "American Journal of Public Health," January, 1916.] Paper; 6x9 in.; pp. 22. 20c.

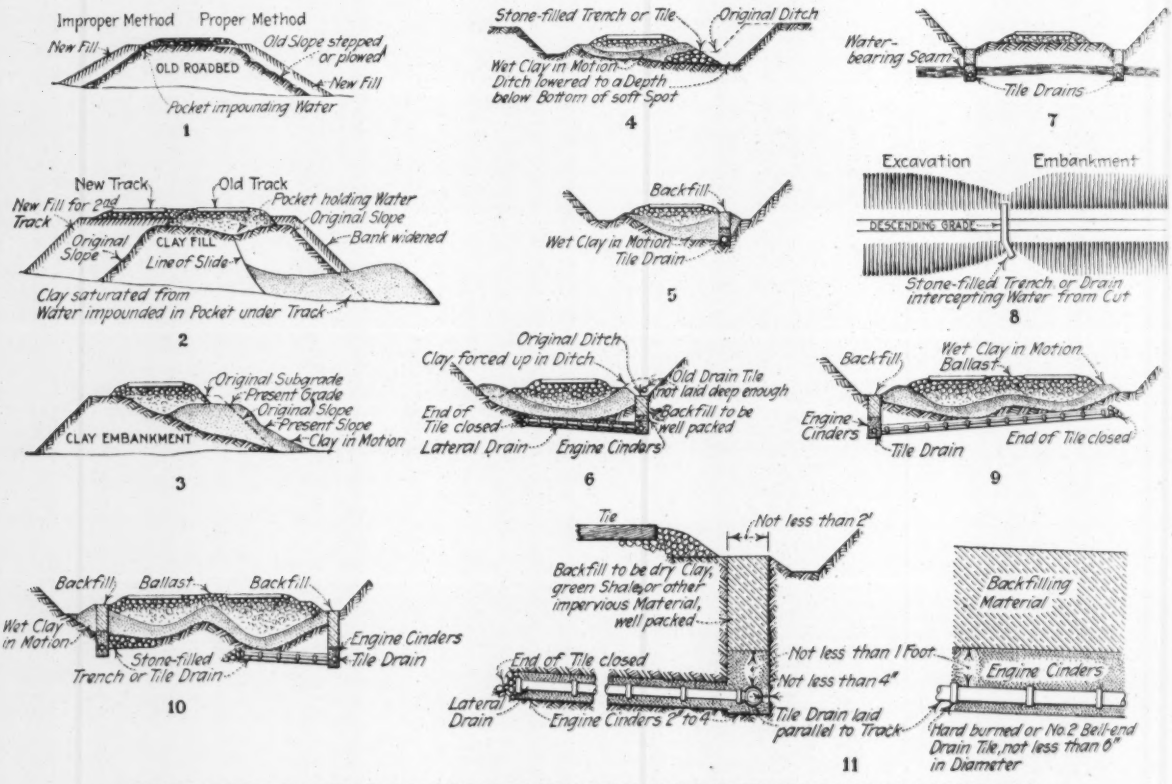
WATER SUPPLIES OF KANSAS: Part I, Ground Water Supplies—By C. A. Haskins, Associate Professor of Civil Engineering; Engineer, State Board of Health, and C. C. Young, Director, Water and Sewage Laboratory, State Board of Health, University of Kansas. Lawrence, Kan.: Engineering Experiment Station University of Kansas. Bulletin No. 5. Paper; 6x9 in.; pp. 187; illustrated.

WATERWAYS OF NEW JERSEY: History of Riparian Ownership and Control Over the Navigable Waters of New Jersey—By Charles S. Boyer, Formerly Member of New Jersey Harbor Commission. Camden, N. J.: Sinnickson Chew & Sons Co. Cloth; 6x9 in.; pp. 295; illustrated. $2 postage prepaid.

Field and Office

Common Causes of Railway Slips and Their Prevention

During the recent flood conditions in the Mississippi Valley the Missouri, Kansas & Texas Ry. was one of the few railroads that maintained uninterrupted service to the Southwest. This record entitles its maintenance-of-way department to some credit and to some inquiry as to methods. The accompanying sketches and notes are based on an instruction sheet prepared in 1915 under the direction of Leon F. Lombladh, Chief Engineer, and on an interview with A. A. Matthews, Engineer of Maintenance-of-Way at Dallas, Tex.



SUBDRAINING RAILWAY ROADBEDS TO PREVENT SLIPS, MISSOURI, KANSAS & TEXAS RY.

A common cause of slips in embankment is illustrated in Fig. 1, where the fill has been widened without properly stepping the old slopes. This new fill of impervious material is often placed in such a way that the shoulders of the fill are higher than the old subgrade, forming pockets or troughs that retain water and cause soft spots in the track. Care should be taken to prevent this by removing the ballast from eroded or settled parts of roadbed and bringing the roadbed to grade with new material; the slopes of the old fill should be plowed before adding new material.

The same precautions apply to roadbeds widened for additional tracks and to widening roadbeds in fills. Two examples of the effects of faulty drainage in widened clay embankments are shown in Figs. 2 and 3. Transverse stone-filled trenches would have prevented these slips.

In cuts, when a soft spot does not extend to a great depth and the cut is shallow, it is economical to widen the cut, lower the side ditch to a depth below the lowest pocket and drain the roadbed into the ditch by means of a stone-filled trench or a tile drain (see Fig. 4). When soft spots have extended too deep to be economically drained by deepening the surface ditches, they should be drained by tiling laid parallel to the track and below the lowest part of the soft spot (see Figs. 5 and 6). In a cut where there is seepage from both sides, intercepting drains should be constructed on both sides of the track (Fig. 7); but if the seepage is from one side only, a single drain should be on that side.

Where there is probability of water from a wet cut entering an adjoining embankment, a tile drain or a stone-filled trench should be constructed across the roadbed near the end of the cut, to intercept the flow (Fig. 8).

Figs. 9 and 10 represent typical conditions of pocket formation in cuts and show the way drains should be laid to take care of such formations.

Fig. 11 gives in detail the method of laying and backfilling tile drains in cuts. Notice that these drains are

for subsurface water and are not intended to take the place of the side ditches.

Some general points to be borne in mind follow: Determine the depth of water in the pockets by digging a hole. Subdrains must always be laid below wet clay or below the lowest point in the pockets. If they are not so laid, they will not drain the pocket and will soon be displaced by slips. Trenches should be made as narrow as possible and should be braced during construction, if necessary. Drains parallel to the track should be laid as close to the track as the stability of the soil will permit and according to their depth, but they should never be nearer to the ends of the ties than 2 ft. The drains should have a fall of not less than 4 in. per 100 ft. In deep trenches and in soft or slipping material only bell-end tile should be used, because it retains its alignment better. The tile should be hard-burned and should never be less than 6 in. in size.

After the trenches have been excavated to grade, about 3 in. of cinders should be placed in the bottom to keep out the wet clay. The tile should be laid on the side of the trench farthest from the track, but not less than 4 in. from the side of the trench. The sections of tile should be laid from the low end of the grade or outlet upgrade, the bell ends upgrade. Joints should be left open enough to permit water to enter, but not so open that dirt can enter. The upper end should be closed with a block of wood or slab of stone, and the outlet should be covered with wire netting to prevent animals from getting in.

The backfill should be made of cinders all around and to 12 in. above the pipe. The joints may be lightly covered with hay or straw while the backfill is being made, to keep the joints open. The fill directly over the cinders should be selected material and should be carefully tamped to insure stability of the roadbed. The tile drain is not intended to take care of surface drainage, the ditches providing for this.

If all pockets are not tapped and drained by drains parallel to the tracks, lateral drains should be laid at such intervals as may be necessary. Vegetation with deep roots must never be allowed to grow up over the subdrains.

Electric, Pneumatic and Hand Tamping of Ballast

An electric machine for tamping railway ballast has been tried on the New York Central R.R. It is described by George W. Vaughan, Engineer of Maintenance-of-Way, in a recent bulletin of the American Railway Engineering Association. The tamper is a rebuilt drill of the kind manufactured by the Chicago Electric Tool Co. and was designed by Mr. Vaughan, who about a year ago invented the pneumatic tie tamper sold by the Ingersoll-Rand Co. The electric tamper can now be purchased from the Chicago Electric Tool Co.

The machine weighs about 90 lb., including the tamping bar. It consumes 3.5 amperes at 220 volts, or 0.77 kw., and delivers 1,000 to 1,200 blows per min. The generating plant is mounted on a small push-car and comprises a 2-kw. dynamo coupled to a 4-hp. gasoline engine. This unit weighs about 680 lb. and can supply current for two tampers. The total weight of car and equipment is about 1,900 lb., but this can be reduced considerably.

In a test with regular section gangs a foreman and 6 laborers tamped 1 mi. of track by hand in 26 days at a cost of $11.52 per day, or $299. A foreman and 5 laborers, with electric tamper and supplies, tamped 1 mi. of track in 15 days at a cost of $10.50 per day, or $157, showing a saving of $142. The cost per tie was 9.4c. by hand and 4.9c. by machine.

The same report describes tests with the pneumatic tamper, which has been described in *Engineering News*. This tamper weighs 37 lb., including the bar, and consumes approximately 19 cu.ft. of free air at 70-lb. pressure. The compressor has a capacity of 45 cu.ft. of free air per minute at 80-lb. pressure and is coupled to a 12-hp. gasoline engine. The outfit complete, mounted on a push-car and including two tampers and several hundred feet of ¾-in. hose, weighs about 2,495 lb.

With hand tamping, a foreman and 10 laborers tamped 1 mi. of track in 13½ days at $21.20 per day, or $282. With the pneumatic machine there was a saving of $196 per day. In another test the cost was 6.5c. per tie by hand and 2c. by machine, or a saving of $144 per mi. (3,200 ties). A gang of 40 men ($61.20 per day) tamped 1 mi. of track by hand in 9 days—$550.80. A gang of 21 men ($32.13 per day) tamped 1 mi. by machine in 13 days—$417.69, or a saving of $133.11 per mi. The pneumatic machine tamping was more effective also, the average settlement after 6 mo. being 0.067 ft. for the hand-tamped track and 0.033 ft. for the machine-tamped track.

Electric Track Tamper Used in Germany

Tamping ballast by electric machines was recently tried out in Germany with marked success, according to G. Schimpff, of Aachen, in *Organ für die Fortschritte des Eisenbahnwesens*, December, 1915. The design of the tamper is shown in Fig. 1. Former trials of electric

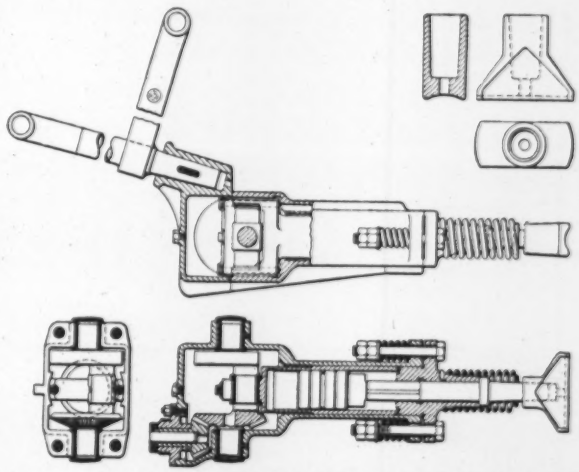


FIG. 1. DESIGN OF ELECTRIC TAMPER RECENTLY USED IN GERMANY

tampers failed to show advantages over hand tamping, chiefly because of the excessive weight and power consumption of the tampers. The present Hampke tamper is brought down to small proportions by using flexible-shaft drive from a stationary power plant and an indirect (air-cushion) action.

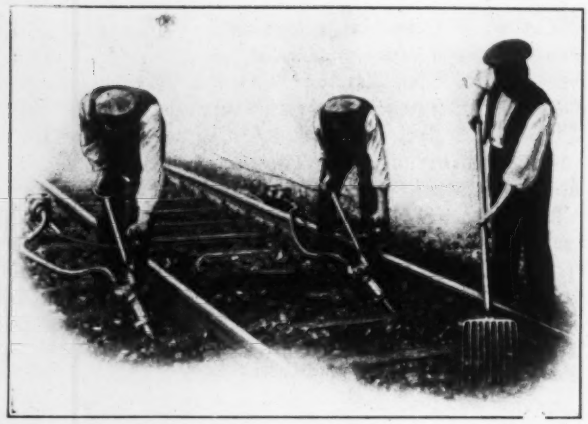


FIG. 2.. TWO OF THE ELECTRIC TAMPERS AT WORK ON THE HAMBURG-BERLIN LINE

The gears and crank in the back of the casing, Fig. 1, drive a reciprocating cylinder within which is a free piston thrown back and forth by air compression in the cylinder. This piston strikes the end of the tamper bar socketed in the front of the casing. The machine weighs 53 lb. Its casing diameter is 4½ in. The tamper bar and head weigh 3½ lb.

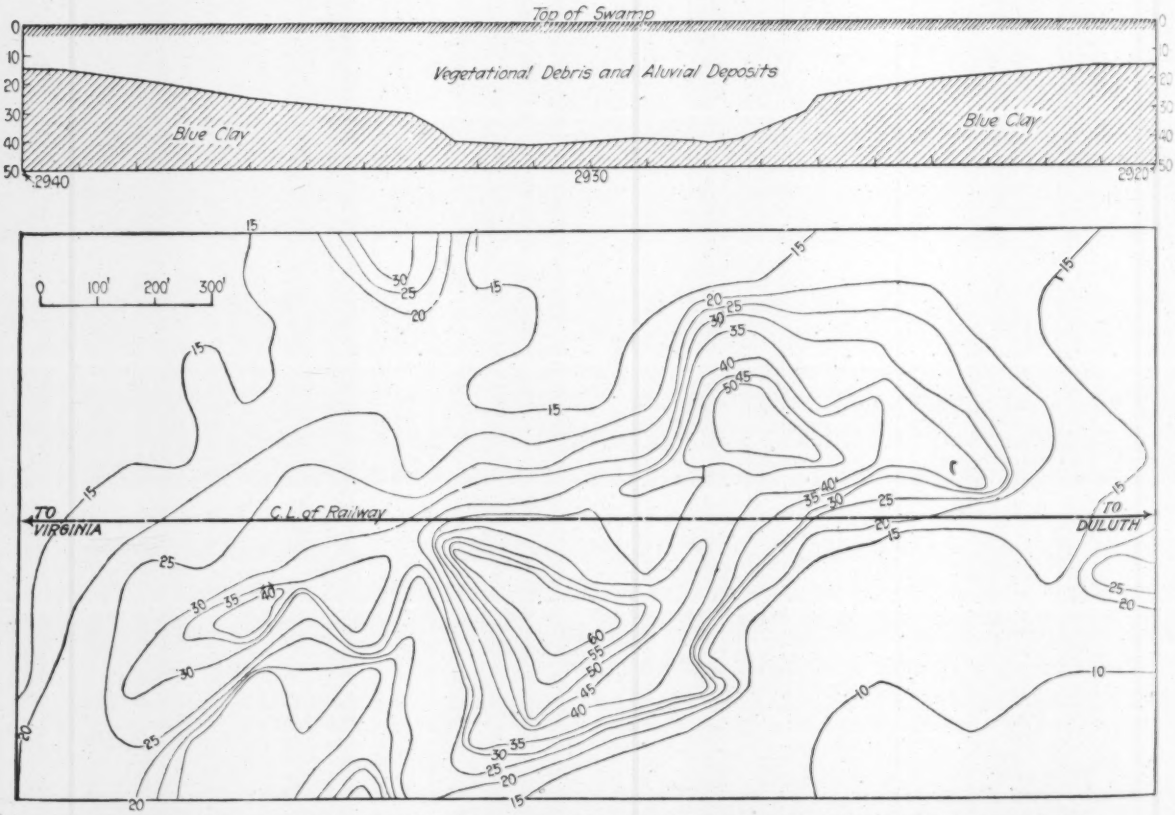
Power is provided by a ¾-hp. motor weighing 46 lb. Where electric current is not readily available, a generator car is used. This is a small truck carrying a direct-current dynamo of 2.3 kw. capacity driven by a 4-hp. benzol engine.

The generator car with distributing cable cost $700 (2,800 M.). The tamper, with motor, cost $245 (980 M.). Fixed charges are computed (at 30% depreciation and 15% interest and maintenance for the tamper, 35% and 10% for the generator car) as 55c. per day for one tamper and 87c. per day for the generator car. Attendance and fuel for the latter are estimated at about $1.50 per day. Working costs with four tampers (9 men in gang, at 80c. per day) are estimated at $11.16 per day, and the daily output of the gang is taken at 500 ft. of track, making a cost of 2.2c. per foot of track. This is said to be 40% below the cost of hand tamping. With hand work 24 men would be required to do the same amount of work per day.

Four of these machines were used on a 5,354-ft. strip of track on the Hamburg-Berlin line between Friedrichsruh and Schwarzenbek. A gang of six men was employed—four tamping and two leveling and smoothing off the ballast. The work proceeded at the rate of 230 ft. per day and was finished in 23 working days.

Building Railways Across Muskeg Swamps

A muskeg swamp is one composed of decayed moss and vegetation that has gradually filled the irregular depressions of a bed of glacial drift. Between this filling and the drift is usually a bed of impervious blue clay. Some of the depressions are of great size and depth, where masses of glacial ice have been embedded and slowly melted. Under these conditions there is no surface indication of the depth of contour of the hard bottom. These swamps are found in the northern part of the United States and in Canada. Some of the diffi-



SECTION AND CONTOUR MAP OF A MUSKEG SWAMP ON THE DULUTH, WINNIPEG & PACIFIC RY.
The contours are at 5-ft. intervals and show the hard bottom of the swamp

culties of locating and building railways in such country were described at the annual meeting of the Minnesota Surveyors and Engineers Society by J. L. Pickles, Chief Engineer of the Duluth, Winnipeg & Pacific Ry.

In making the location the engineer is apt to take it for granted that the muskeg is shallow and will support the roadbed. There is strong temptation to lay long tangents across the level and open surface of the swamp rather than to adopt a more irregular line in the neighboring higher hard ground, whose roughness is apparent and which is invariably covered with thick vegetation. It is advisable, however, to proceed as in locating over frozen lakes and not trust the moss covering until its bearing value has been tested by soundings. Such tests will often show that the surface is floating, the old pool or depression not being filled to the bottom. Where the depth is less than 15 ft., the swamp will usually carry traffic. The areas void of tree growth should be regarded with suspicion, as this feature usually indicates deep and recent formation and quite often indicates floating bog.

On some railways it has been found that, had adequate soundings been made previous to final location, much money could have been saved over what was necessarily spent to bring the road up to the required standard after operation was begun. An example is shown by the accompanying drawing. As constructed, the line had a heavy corduroy foundation, but this broke through the crust before traffic was started. Soundings after failure showed a depth of about 60 ft. to apparently hard bottom. About 83,000 yd. of material was required to bring the track above water again, and much time and money were lost, which would have been avoided had adequate soundings been taken during the location.

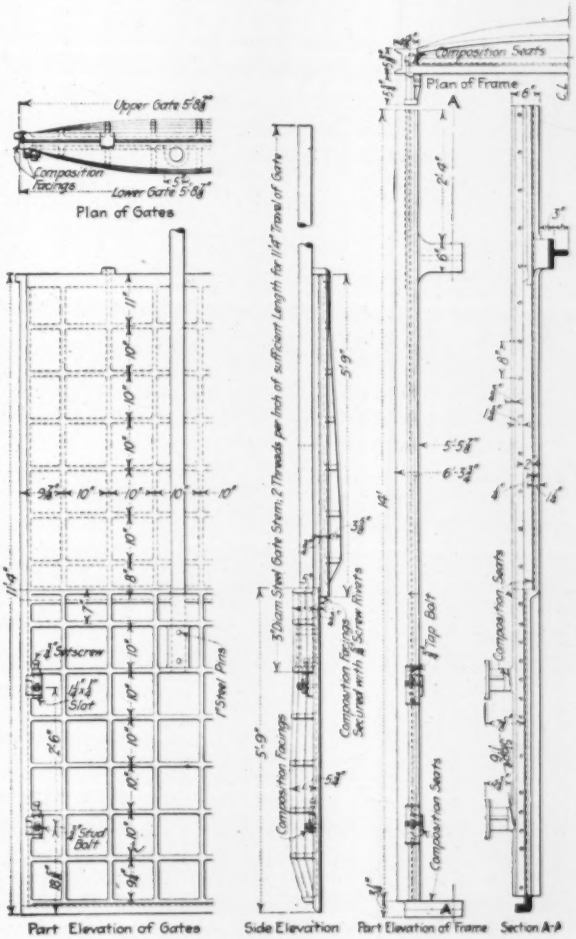
In railway construction over muskeg swamps the methods in general use are as follows: 1. To follow the usual form of construction, laying the track directly on the surface and afterward ballasting up to grade. 2. To corduroy or crossway the surface with long timbers, in alternate layers parallel and transverse to the line, afterward bringing the track to grade with ballast. 3. To excavate ditches along each side and use the material to form an embankment. 4. To use sawdust, cinders or other light material to carry the line, depending on the buoyancy of the muskeg for support. 5. To fill to the bottom with logs and timber. 6. To fill with excavated material. 7. To build a trestle. 8. Where considerable embankment is to be carried over the swamp, piles have been driven about 4 ft. c. to c., capped with timber grillage on which the fill is deposited.

Drainage often gives beneficial results; but where deep muskeg is encountered, such work is often impracticable, owing to lakes in the vicinity and the heavy expense required for the great length of ditches necessary to reach an outlet. Ditches cut in muskeg are apt to close, and it is a constant source of expense to keep them open. While such ditches are of more benefit to the surrounding country than to the railways, they give rise to suits in which the company is usually the loser. Mr. Pickles stated that for this reason many of the swamps in the northern part of Minnesota are not drained.

Whatever form of construction is decided upon, a good foundation must be obtained. Otherwise there will be constant expense and trouble from settlement and rail running (causing broken rails, derailments, etc.), which will result in heavy maintenance charges. In locations over muskeg country it is well to keep the grade as near the surface as good drainage will permit, in order to prevent overloading. Heavy embankments may break through the surface and in some instances will cause rupture through the underlying strata into the substratum, which is of an older formation but not yet solidified sufficiently to carry the increased load.

"Double-Hung" Sluice Gate

In the construction of the new hydro-electric power station at the Sudbury dam in Southboro, Mass., the Metropolitan Water and Sewerage Board is installing three large sluice gates of novel design. The height of the opening is so great that if the sluice gates were made in one piece, they would project above the floor of the



SAVING GATE SPACE IN A POWER PLANT BY USING TWO-LEAF HUNG GATES

gate house when opened. As this was not desirable, designs were made for a gate consisting of two parts like a hung window, but operating somewhat different.

The gate stem is attached to the lower half, which when raised to the point where its top edge or meeting rail reaches the top edge of the upper half engages with lugs on the upper half and carries it along. The gate therefore occupies, when open, practically one-half the vertical space that it covers when closed. Details of design are shown in the accompanying sketch.

Mathematicians and Computers Solve Sphere Problem

A computation problem of unusual difficulty, published in *Engineering News*, Jan. 27, 1915, p. 176, set a large number of readers to work devising a method for solving the problem and making the computation. The problem is to find the volume of the part segment cut out of a sphere of 7-ft. radius by two planes at right angles to each other, such that the widths of the two faces are 3 ft. and 0.963 ft. respectively (see Fig. 1).

Most of the computers adopted the prismoidal formula, without any demonstration of its applicability to the case. Three ways of applying the formula were used by the solvers of the problem, and the results for the three differ, which proves that the formula is approximate and not exact for the sphere segment.

Trying the calculus to get an exact formula for the volume, a hopeless-looking integral is obtained. Nevertheless, four men succeeded in performing the integration and obtained the exact volume formula thereby. They are Prof. H. W. Reddick, Cooper Union, New York City; Prof. James E Boyd, Ohio State University, Columbus; J. M. Sorensen, Chicago, Milwaukee & St. Paul Ry., Chicago, who also gave the derivation in detail; and George Paaswell, New York City.

Exact Volume Formula by Integration

The differential expression can be established for rectangular coördinates with either triple integration or with single integration; and for polar coördinates around the center of the sphere, with triple integration. The various methods lead to substantially similar forms of integral. The simplest process is to use single integration with rectangular coördinates, inasmuch as the area of the circular segment is easly expressed by geometry and algebra.

In Fig. 2 the given quantities are L and H, besides the radius R. From these the distances a and b of the cutting

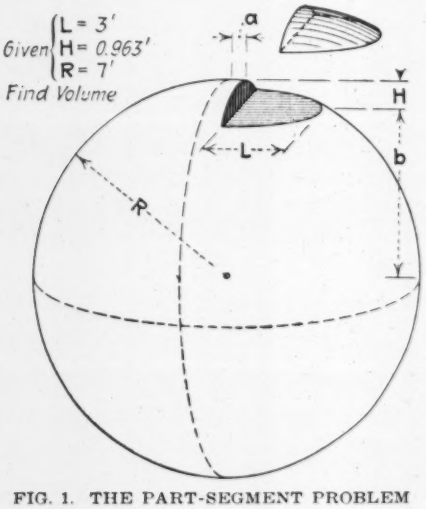


FIG. 1. THE PART-SEGMENT PROBLEM

planes from the parallel median planes of the sphere are readily computed. The elements of the horizontal section of the segment and the formula for the volume are conveniently expressed in terms of a and b instead of in the originally given quantities. Fig. 2 shows a side elevation of the sphere, where any horizontal section of the part segment, at the (variable) height z above the horizontal center plane of the sphere, has radius r and width $r - a$. In plan this horizontal section, Fig. 3, has a half-central angle A equal to $\cos^{-1}\frac{a}{r}$. The area of the sector, equal to half the length of the arc times the radius, is equal to Ar^2, and the area of the triangle that must be subtracted is $a\sqrt{r^2 - a^2}$. But the variable r must be expressed

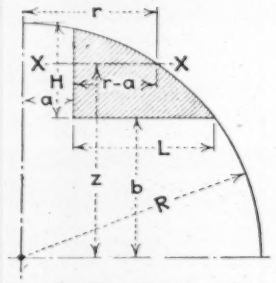


FIG. 2. FRONT ELEVATION OR VERTICAL SECTION

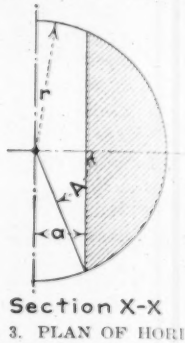


FIG. 3. PLAN OF HORIZONTAL SECTION

in terms of the principal variable z by the relation (see Fig. 2) $r = \sqrt{R^2 - z^2}$. Making the substitution, the formula for the area of the circular segment is

$$S = (R^2 - z^2)\cos^{-1}\frac{a}{\sqrt{R^2 - z^2}} - a\sqrt{R^2 - a^2 - z^2}$$

Using this expression, direct integration on z gives the volume of the segment if the proper limits are used:

$$Volume = \int_b^{\sqrt{R^2 - a^2}} (R^2 - z^2)\cos^{-1}\frac{a}{\sqrt{R^2 - z^2}}\,dz - a\int_b^{\sqrt{R^2 - a^2}} \sqrt{R^2 - a^2 - z^2}\,dz$$

The second integral is a common form that may be found in practically every integral table or can be brought into directly manageable shape by substituting for z the value $\sqrt{R^2 - a^2}\sin u$. The difficulties arise with the first integral. Its integration is as follows:

$$\int (R^2 - z^2)\cos^{-1}\frac{a}{\sqrt{R^2 - z^2}}\,dz = \int \cos^{-1}\frac{a}{\sqrt{R^2 - z^2}}\,d\left(R^2 z - \frac{z^3}{3}\right)$$

Integrating by parts, according to the scheme $\int v\,du = uv - \int u\,dv$, the integral becomes

$$\left(R^2 z - \frac{z^3}{3}\right)\cos^{-1}\frac{a}{\sqrt{R^2 - z^2}} + \int \left(R^2 z - \frac{z^3}{3}\right)\frac{az\,dz}{\sqrt{R^2 - a^2 - z^2}\,(R^2 - z^2)}$$

In the last integral the following simplification is made:

$$\frac{\left(R^2 z - \frac{z^3}{3}\right)z}{R^2 - z^2} = \frac{\frac{z^2}{3}(3R^2 - z^2)}{R^2 - z^2} = \frac{z^2}{3} - \frac{2}{3}R^2 + \frac{2R^4}{3(R^2 - z^2)}$$

so that we have

$$\left(R^2 z - \frac{z^3}{3}\right)\cos^{-1}\frac{a}{\sqrt{R^2 - z^2}} + \frac{a}{3}\int \frac{z^2 dz}{\sqrt{R^2 - a^2 - z^2}} - \frac{2aR^2}{3}\int \frac{dz}{\sqrt{R^2 - a^2 - z^2}} + \frac{2aR^4}{3}\int \frac{dz}{(R^2 - z^2)\sqrt{R^2 - a^2 - z^2}}$$

The first two of these integrals simplify easily by the substitution

$$z = \sqrt{R^2 - a^2}\cos u$$

The third integral can by the same substitution be brought into the form $\int \frac{du}{A + B\cos u}$, which is found in most tables, integrating into inverse-tangent form; or it can be found direct in inverse-cosine form in the larger integral tables. The three integrals then are:

$$\frac{a}{3}\int \frac{z^2 dz}{\sqrt{R^2 - a^2 - z^2}} = -\frac{az}{6}\sqrt{R^2 - a^2 - z^2}$$

$$-\frac{a}{6}(R^2 - a^2).\cos^{-1}\frac{z}{\sqrt{R^2 - a^2}}$$

$$\frac{2aR^2}{3}\int \frac{dz}{\sqrt{R^2 - a^2 - z^2}} = -\frac{2aR^2}{3}\cos^{-1}\frac{z}{\sqrt{R^2 - a^2}}$$

$$\frac{2aR^4}{3}\int \frac{dz}{(R^2 - z^2)\sqrt{R^2 - a^2 - z^2}} =$$

$$-\tfrac{2}{3}R^3 \tan^{-1}\frac{R\sqrt{R^2 - a^2 - z^2}}{az} =$$

$$-\tfrac{2}{3}R^3 \cos^{-1}\frac{az}{\sqrt{R^2 - z^2}\sqrt{R^2 - a^2}}$$

Then the complete integral of the two terms that make up the volume becomes, after substituting the limits of integration:

$$Volume = \tfrac{2}{3}ab\sqrt{R^2 - a^2 - b^2}$$

$$+\tfrac{2}{3}R^3 \cos^{-1}\frac{ab}{\sqrt{R^2 - a^2}\sqrt{R^2 - b^2}}$$

$$-\tfrac{1}{3}a(3R^2 - a^2)\cos^{-1}\frac{b}{\sqrt{R^2 - a^2}}$$

$$-\tfrac{1}{3}b(3R^2 - b^2)\cos^{-1}\frac{a}{\sqrt{R^2 - b^2}}$$

It is noticed that the formula is completely symmetrical in a and b, as the geometrical conditions require. Making either a or b equal to zero, the formula reduces to the well-known expression for the volume of a full spherical segment. For example, making b equal zero, the volume of a half-segment is given:

$$Volume = \frac{\pi R^3}{3} - \frac{\pi a}{6}(3R^2 - a^2) = \frac{\pi h^2}{6}(3R - h)$$

which can be derived direct from the volume of the spherical sector and the cone cut off from it by a plane.

Mr. Paaswell gives the integration in a different form. Using the radius of the base circle of the segment, $r = \sqrt{R^2 - b^2}$, his solution is:

$$Volume = \tfrac{2}{3}ab\sqrt{r^2 - a^2} + \frac{\pi}{6}(2R^2(R - b) - br^2) +$$

$$\tfrac{1}{3}b(2R^2 + r^2)\sin^{-1}\frac{a}{r} - \tfrac{1}{3}a(3R^2 - a^2)\tan^{-1}\frac{\sqrt{r^2 - a^2}}{b}$$

$$-\tfrac{2}{3}R^3 \tan^{-1}\frac{ab}{R\sqrt{r^2 - a^2}}$$

This formula, which can be transformed into the other algebraically, is claimed to be better for the present example, because the numerical values of the several terms are lower, the largest being about 36.

Professor Boyd computes by the formula the value 7.46 cu.ft. as the volume of the part segment. Mr. Sorensen, using a larger number of decimal places, obtains 7.4537. Mr. Paaswell gets 7.4044, which he says is probably correct to the third decimal place. Professor Reddick does not give a numerical solution but S. L. Peebles, New York City, computed by his formula the value 7.452. A seven-place computation gives 7.45204 cu.ft.

The accuracy of the computation is affected by the transformations required in computing the three inverse cosine terms, as well as by the fact that the formula is one of differences. The four terms according to Mr. Sorensen's calculation are given in the numerical equation

$$V = 8.2871 + 326.9387 - 312.5767 - 15.1957 = 7.4537$$

Thus the individual terms from which the result is computed are over 40 times as large as the result, and the final volume has nearly two places less of accuracy than the computations up to that point.

Different Applications of Prismoidal Formula

Application of the familiar prismoidal formula is subject to the uncertainty of how truly this formula applies to the segment of a sphere or part of such a segment. By comparing the result of the prismoidal-formula calculation with the result from the integrated formula the correctness of the prismoidal formula for this case can be judged.

The prismoidal formula can be applied with either face of the part segment as a base, or it can be applied to that part of the half-segment which is cut away (lying between the inner face of the segment and the median plane of the sphere). In the latter case, of course, the volume of the complete segment is computed by the geometrical formula

$$V = \frac{\pi h^2}{3}(3R - h)$$

With the 3-ft. face of the segment as base, computations were made by Frank S. Bailey, East Braintree, Mass., who obtained 7.5106 cu.ft.; S. Arkin, New York City, 7.51, and S. L. Peebles, New York City, 7.510. A check confirms all these to the third place.

With the 0.963-ft. face of the segment as base, S. Arkin obtained 7.47, and S. L. Peebles 7.568. A check with seven-place work gives 7.56734. As might be expected, the error of this calculation is greater than that of the preceding, as the body is higher and has more curvature.

The subtractive prismoidal method, computing the volume of the half-segment and deducting the small piece adjoining the median plane of the sphere, was adopted by a number, but several of these were content to use the average-end-area method for getting the volume of the small subtractive piece.

The advantage of the subtractive computation is that the influence of the approximation is minimized. On the other hand, there is more detail computation, as three circular segments have to be computed.

Typical results with prismoidal subtraction are: Edward Godfrey, Pittsburgh, Penn., 7.478 with three-place work; E. J. Creighton, Denver, Colo., 7.54 (with some approximations to shorten the computation of the circular segments); seven-place check computation, 7.4525.

A slight variation, to save labor, was employed by E. A. Batley, Rome, N. Y., and S. Arkin, New York City, who found first the volume of the full spherical segment and then deducted the central part symmetrical about the vertical median plane of the sphere, computing the vol-

ume of this subtractive portion by the prismoidal formula. Their results are 7.482 and 7.495 cu.ft.

Average-end-area subtraction gave the following results, among others: Prof. James E. Boyd, Columbus, Ohio, 7.46; E. E. Halmos, New York City, 7.51; Charles W. Chassaing, East St. Louis, Ill., 7.52; A. Yappen, Chicago, 7.747.

An interesting misinterpretation of the problem was made by one correspondent, who took it to call for the volume of the torus whose ring-section is the circular part segment of base 3 ft. and height 0.963 ft., the axis of revolution being parallel to the 0.963-ft. face.

Further Results; Area of Surface; Volume of Three-Plane Segment

Prof. H. W. Reddick, New York City, whose integration of the volume has been mentioned, also integrated the curved surface of the part segment. He gives the formula:

$$S = 2R\left(R\cos^{-1}\frac{ab}{\sqrt{R^2-a^2}\sqrt{R^2-b^2}} - b\cos^{-1}\frac{a}{\sqrt{R^2-b^2}} - a\cos^{-1}\frac{b}{\sqrt{R^2-a^2}}\right)$$

The scope of the integration has been extended by Mr. Sorensen to the case of a segment bounded by three planes

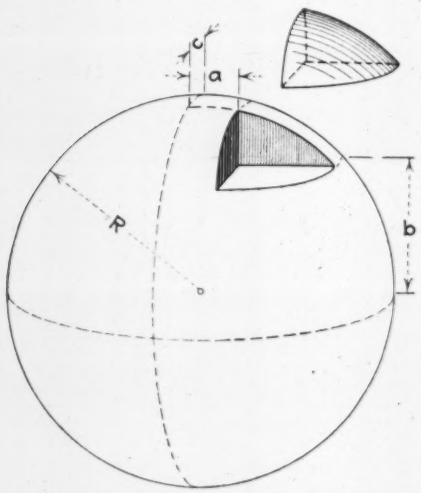


FIG. 4. GENERAL CASE; THREE CUTTING PLANES AT RIGHT ANGLES

at right angles, Fig. 4. The solution, obtained by methods similar to those used in the previous case, is:

$$\text{Volume} = \frac{ab}{3}\sqrt{R^2-a^2-b^2} + \frac{bc}{3}\sqrt{R^2-b^2-c^2} + \frac{ac}{3}\sqrt{R^2-a^2-c^2} - abc$$
$$-\frac{a}{6}(3R^2-a^2)\cos^{-1}\frac{c\sqrt{R^2-a^2-b^2}+b\sqrt{R^2-a^2-c^2}}{R^2-a^2}$$
$$-\frac{b}{6}(3R^2-b^2)\cos^{-1}\frac{a\sqrt{R^2-b^2-c^2}+c\sqrt{R^2-a^2-b^2}}{R^2-b^2}$$
$$-\frac{c}{6}(3R^2-c^2)\cos^{-1}\frac{a\sqrt{R^2-b^2-c^2}+b\sqrt{R^2-a^2-c^2}}{R^2-c^2}$$
$$+\tfrac{1}{3}R^3\left(\cos^{-1}\frac{ab}{\sqrt{R^2-a^2}\sqrt{R^2-b^2}}+\cos^{-1}\frac{bc}{\sqrt{R^2-b^2}\sqrt{R^2-c^2}} + \cos^{-1}\frac{ac}{\sqrt{R^2-a^2}\sqrt{R^2-c^2}}\right)$$

Here, as in the previous example, the distances of the three cutting planes from the center of the sphere, a, b and c, are to be computed from the given quantities. If the three lengths of the segment are given, L, M and N, three formulas can be written:

$$(a+L)^2 + b^2 + c^2 = R^2$$
$$a^2 + (b+M)^2 + c^2 = R^2$$
$$a^2 + b^2 + (c+N)^2 = R^2$$

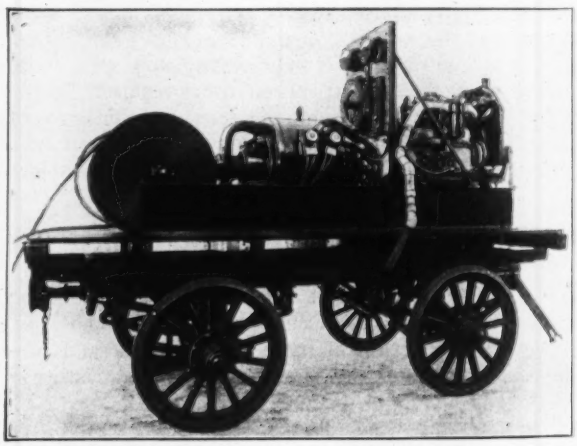
which are solved as numerical equations.

The labor involved in all the analyses and calculations connected with this problem is very considerable. The voluntary coöperation of so many able computers in working out the problem is worthy of special commendation.

NOTES

Rapid Rail Renewal with Locomotive Cranes is reported by the Lehigh Valley R.R. On 4.07 mi. of track between Gilbert and Lodi, N. Y., the track was relaid with 100-lb. rails in about 6 hr. and the track entirely completed and the old rails picked up and loaded on cars 6 hr. later. This work was done by four cranes without interrupting traffic. The railroad uses this equipment extensively in trackwork. It owns about 30 locomotive cranes and has purchased 6 more.

St. Paul's Electric Pipe-Thawing Machine—In St. Paul, Minn., an electric pipe-thawing outfit has just been put in service by the municipal water department. It was built from specifications drawn by G. O. House, General Superintendent and Engineer. In such a climate as St. Paul's, where frost goes down 5 ft. and at times 7 ft., frozen water pipes, especially house connections, are not unusual. When the thawing out was dependent on digging down to the frozen pipe, annoying and often serious delays followed. This machine consists essentially of a four-cylinder 1,000-r.p.m. automobile engine driving a 20-kw. direct-current 40-volt generator, a field rheostat (for regulating voltage from 0 to 40), 500 ft. of insulated 300,000-cm. copper cable in 100-ft. lengths, a reel, etc., all mounted on a 1½-ton trailer truck with solid rubber tires. To thaw out a main, the necessary



ST. PAUL'S ELECTRIC THAWING TRUCK

lengths of cable are reeled off and run from the generator to convenient connections of the frozen pipe, and the engine is started. The machine has been practically tested during a recent low-temperature period with remarkable results. 4 to 5 min. sufficing to clear a frozen pipe that would probably have taken one or two days, if dug for. The machine was built for city use, but may be hired by plumbers at a reasonable rental. It is estimated that the machine will pay for itself in two years by direct saving in money plus the indirect saving from time once expended in digging. The unit cost $2,700 ($700 for the truck and $2,000 for the equipment set up). The engine was made by the Capital Engine Works, St. Paul; the generator by Roth Brothers, Chicago; and the tractor by the Troy Wagon Works, Troy, Ohio. The machine was assembled by E. L. Sudheimer, St. Paul.

Editorials

Air and Electric Track Tampers Are Both Successful

Tamping railway ties, until the summer of 1913, was done wholly by human muscle. About that time a pneumatic tie tamper appeared upon the market. That this machine is successful is evidenced by its rapid introduction on both steam and electric railways. At the present time the New York Central R.R. owns pneumatic-tamping equipment to the value of $75,000; and the machines are in use on the Lehigh Valley, the Pennsylvania, Hudson & Manhattan, Erie, Delaware, Lackawanna & Western R.R. and other railways.

Two years ago G. W. Vaughan, Engineer of Maintenance-of-Way of the New York Central lines—the inventor of the pneumatic tamping machine, began experimenting with an electric tamping device of his own design. In the midst of his experiments a derailment destroyed the machine; but a new one was constructed, which has worked satisfactorily and is now on the market. Another electric tamper, of quite different design from Mr. Vaughan's, has recently been developed in Germany. Both machines are described in this issue.

Now that a start has been made in the commercial use of power tamping machines, there is reason to believe that their employment will be extended very rapidly. For some years past there has been increasing difficulty in securing men for track-maintenance work, and this difficulty is rapidly growing acute. Merely by the operation of the law of supply and demand the railways are going to be compelled to pay higher wages to trackmen. Reliance on breaking in new men to the work from recently arrived immigrants fails when the tide of immigration is cut off.

The use of machines which enable a man to accomplish more work and which require less muscle will make it possible to hold men who otherwise would quit for some less laborious occupation. The surprising thing is that man power—the most costly form of power—should have so long continued to be the exclusive reliance for the hard work of tamping ties.

Hardness Tests for Bronzes

Hardness tests have been used far less in this country than they deserve. The specification of the Brinell test for bronzes by the New York Central Railroad Co. is interesting in this respect. It is even more interesting because a compression test is coupled with the Brinell test, and some metals are judged mainly by the first, while others are judged by the second test.

Both tests are measures of hardness, in a way. For heavy service chief dependence seems to be placed on compressive strength and the ability of the material to stand a certain degree of squeezing out of shape without cracking. By specifying certain values for these two qualities a measure of plasticity is obtained in conjunction with a measure of hardness. Evidently, the object is to get an indication of load-carrying ability and of anti-friction qualities. The Brinell test, giving only one figure instead of two, supplies no information on plasticity.

Of the relation between this type of compression test and the hardness test little is known. Probably the relation is not the same for a material of distinctly composite structure, as a bronze, that it is for a more nearly homogeneous material, as steel. On this question, however, it is likely that students of micrography will have pronounced individual opinions.

South Orange Grade Elevation a Notable Construction

Even without the authority of statistics it is probably safe to say that the amount of money being expended by the railways of the country on grade-crossing elimination far surpasses all sums being spent on other railway construction. The demand for safe crossings is being successfully enforced by not only the large cities, but by the smaller towns and villages, while at the same time the dictates of economy force the railway to the high first cost of crossing elimination to offset the continual expense of watchmen at crossings and the occasional, but inevitable, damage suit. Necessarily the increase in this work has brought about a development in the type of structure used, and the old plate-girder street crossings almost universal a decade ago are being superseded by bridges which, while possibly not more economical, are certainly much more pleasing to the eye and which give promise of longer life.

Of these newer types none is more novel or more artistic than the recently completed South Orange overhead crossing of the Lackawanna R.R., described on another page of this issue. Girderless slabs of reinforced concrete are not new for railway work—the Soo Line freight station at Chicago is now over two years old—but the use is sufficiently rare to call for comment. In this particular case only a thorough analysis could show whether the design is the most economical that could have been used, although the required variation of span length and skew are undoubtedly taken care of much more readily with the flat-slab design than with any other available; but there is no doubt that the long spans and flat ceiling lend themselves admirably to the artistic development of a structure into the embellishment of which was put so much effort. This embellishment, which consists not only of discreet ornamentation, but also of a bush-hammered surface of superior quality, no doubt lends much to the appearance of the structure. It would be well worth the while of the railroad to conduct free excursions to the South Orange crossing for the benefit of those citizens of the lower Oranges who have for so long stood out for track depression through their cities.

In the great amount of reconstruction the Lackawanna has been carrying out in the suburban zone outside of New York it has been the consistent policy of the road

to lay great stress on the appearance of the stations. In this respect the South Orange work is fully up to the previous high standards. The utilization of the inter-column space beneath the track floor for carriage and motor stands, sidewalks and station accommodations has made a virtue rather than a detriment of the track elevation and has permitted a most satisfactory architectural solution of the station-building problem.

The Pennsylvania Investigation of Licensing Engineers

Three years ago the Pennsylvania legislature passed an act creating a commission of five engineers, "to investigate the advisability of licensing engineers who are engaged upon the construction, maintenance and operation of work, public and private, where unusual hazards exist."

The commission appointed by the governor to carry out this task was made up of F. Herbert Snow, chairman, John Price Jackson, secretary, and Samuel A. Taylor, George S. Webster and J. Murray Africa. Some conclusions of this commission were printed on page 484 of our last week's issue. The complete report of the commission is soon to be printed and made available to the public and presents for the first time a complete discussion of the proposal to regulate the practice of engineering by state laws, with the arguments for and against it.

For more than a dozen years the subject of state legislation to regulate the practice of engineering has been discussed by engineers, and laws providing a limited amount of such regulation have been enacted in several states. The subject is one on which opinions in the profession differ radically. Speaking broadly, it is probably the case that the bulk of engineers who have achieved success are opposed to state regulation. On the other hand, there are many, especially of the younger men, who have come to believe that many of the difficulties and disadvantages under which the profession labors can be removed by proper legislation and that such legislation would operate to improve the condition of a large proportion of engineers.

As to what form such regulation should take, ideas in general have been extremely hazy. Very few engineers anywhere have really given such systematic thought and study to this subject as they would give to a technical problem in engineering. The whole engineering profession, therefore, owes a debt to the State of Pennsylvania and particularly to the five eminent engineers who have carried out this investigation and whose official report will henceforth be the textbook of those who care to investigate seriously the state regulation of engineering practice.

Their report, of which 4,000 copies are to be printed for free distribution, ought to be placed in the reference library of every engineering society, every engineering school and in the legislative reference library at every state capital. Many engineers in private practice, also, we doubt not, who have taken an active interest in this subject will wish to secure a copy of the book.

It may be of interest at this point to summarize a little hitherto unwritten history concerning the agitation for state licensing of engineers. After the agitation in Canada some 15 years ago, when it was attempted to give members of the Canadian Society of Civil Engineers the sole right to practice engineering in the Dominion, little was heard of laws to regulate engineering practice until an organization in New York City, known as the Technical League, took up the idea and introduced bills in the New York legislature to carry its plans into effect. For several years in succession bills of this sort were introduced, and delegations of well-known engineers went to Albany to oppose them, succeeding in each case in having them killed in the committee. None was ever reported to the legislature. It became evident, however, that there was a considerable element of the profession which favored such legislation, and the number included some eminent members.

On the plea that if such legislation was at any time to be forced upon the profession, engineers themselves should plan the form which it should take, a joint committee was organized, made up of representatives of five of the national engineering societies, under the chairmanship of the late Alfred Noble, for the purpose of drafting such a model bill.

This committee, it should be said, was far from unanimous in its opinion concerning such legislation. It took as a basis, however, a bill that had previously been drafted by a committee of the American Society of Civil Engineers and which was of the most sweeping character, requiring engineers engaged in any class of engineering work whatever, except military engineering, and whether in private or in public work, to pass examinations and take out licenses in order to practice their profession. This committee, after several meetings, finally reached a deadlock in its deliberations and adjourned. The bill that it had nearly completed has never been reported to or approved by the governing board of any of the national societies that were represented on the committee.

Copies of this bill, however, reached the members of the State Engineering Commission of Pennsylvania and were used by that commission as the basis of a draft of a bill that it prepared for the purpose of arousing public interest and discussion among the engineers of Pennsylvania on the general subject of state regulation of the engineering profession. The commission held public hearings in the fall of 1914 at Pittsburgh, Philadelphia and Harrisburg, which were well attended by prominent engineers. The bill was also taken up for discussion by the Association of Philadelphia Members of the American Society of Civil Engineers, by the Engineers' Club of Philadelphia, by the Philadelphia Section of the American Institute of Electrical Engineers, by the Engineers' Society of Western Pennsylvania and by the Engineers' Society of Pennsylvania.

From the discussion at these public hearings and before these engineering societies, which is presented in full in this report, it is apparent that the proposal that all engineers should be licensed and examined by state authority meets the well-nigh unanimous condemnation of the engineering profession. On the other hand, it is equally evident that there are many unsatisfactory conditions in the practice of engineering as at present carried on, which the profession itself has thus far been unable to remedy and which seems to require some sort of state legislation for the protection of the public and of reputable members of the profession.

In the summary of the commission's conclusions, printed in our last issue, a plan is recommended under which engineers engaged in public service, whether of cities, states or counties, would have their qualifications

tested. Engineers engaged in subordinate positions would have to pass civil-service examinations. Engineers who are candidates for higher positions would be judged on their past professional record, just as they would be were they to enter the service of a private firm or corporation. Engineers engaged in general practice, who do work for cities on a fee basis, would be required to file with some public authority a sworn statement of their professional record, giving testimonials, etc. The authorities of a city or town desiring to engage an engineer, therefore, could by reference to these state records ascertain what the men who had applied for the work or others whom it might wish to engage had done in the past. The board with which such certificates of professional record were filed would have authority to cancel such registration for cause, such as fraudulent representation.

A perusal of the commission's report makes it evident that the members of the commission were much more favorably disposed to, and inclined to go much farther in, state regulation than were most of the prominent engineers who appeared before the commission at its hearings. An explanation for this may be found probably in the fact that Mr. Snow, the chairman of the commission, in his work as chief engineer of the Pennsylvania Department of Health has to examine and pass upon the plans for certain municipal works submitted by engineers employed by cities in Pennsylvania. He is familiar, as few engineers are, with the extent to which smaller municipalities often suffer from the employment of incompetent engineers.

At the present time there appears to be a decided lull in the agitation for state licensing of engineers. For two years in succession now, nothing has been heard of the subject in the New York legislature; and with the multitude of other more important subjects pressing upon public attention, there seems little likelihood of legislation of this sort going forward unless engineers themselves organize and work to secure it.

Wherever and whenever such legislation is proposed, however, the profession is fortunate henceforth in having the Pennsylvania report at hand as a textbook to indicate what not to do, as well as the directions from which some benefit to the public and the profession may be expected.

Garbage Reduction Encouraged

The reactions of the European War show themselves with unexpected force in unsuspected places. For instance, a year ago it was predicted that the price of garbage grease would slump because of war conditions. Instead, it has reached the remarkably high figure of 6.26c. per lb. at Cleveland, owing to the heavy demand for grease for glycerin and red oil for dyestuffs. It is reasonable to suppose that garbage tankage prices would also rise with the curtailment of nitrate and phosphate supplies. Of course, war prices afford narrow and unstable foundations for permanent investments; but the after-war readjustments in the field of the products named are likely to take so long as to warrant garbage-reduction works to enlarge and perfect their equipment with no loss of time, in order to reap the benefit of present high prices and build up reserves for lean years, if they come.

To what extent the high prices should encourage the establishment of new garbage-reduction plants is a matter for careful consideration in connection with a variety of local conditions that should be given careful engineering study in each case. Certainly, if there was ever a time when garbage-reduction could hold its own against incineration, it is in this year of 1916. Doubtless the proprietors of processes and manufacturers of apparatus for garbage-reduction works are already sitting up and taking notice.

War and Water Purification

The high price of most of the chemicals used in water purification, reviewed elsewhere in this issue, is a serious matter, but far less serious than it would be if liquid chlorine were not available. That agent was already displacing hypochlorite of lime before the war prices came on. Its price has gone up, but the advance is nothing like that for hypochlorite. Fortunately, the unit cost of disinfection by either agent is still so low as to be insignificant when compared with the safety that is insured by its use.

As matters stand, the heaviest burden that war prices place on water-works plants comes through the increase of three or four times in the price of sulphate of alumina, which is widely used as a coagulant and is a considerable item in water-works expenses even under normal conditions. Luckily, water-works superintendents can get along with less of this agent now than before chlorine disinfection came into use.

Since lime has not advanced in price and sulphate of iron is not much more costly than before, the water-works using these materials or which perchance can turn to them are in a fortunate position.

All who are called upon to exercise control over the efficiency of water-purification plants that use any of the high-priced chemicals should be constantly on the alert in these days lest the desire to keep expenses from rising should get the better of the determination to supply safe water at any cost.

A word of caution may well be offered to those who are concerned with sewage-treatment plants employing chlorine disinfection. It is hard enough at best to maintain the use of enough hyprchlorite or liquid chlorine to be of much real service in sewage disinfection. Under existing prices, particularly where hypochlorite is used, skimping, or even cutting out disinfection entirely, may be expected by all except the most conscientious superintendents and the best-financed plants.

Finally, there is much in the present situation to make stronger than ever before the already forcible argument for substituting liquid chlorine for hypochlorite in both water purification and sewage treatment.

Merchants Turn City Planners

A stir was caused in New York City a few days ago by page advertisements in the newspapers, in which leading merchants pleaded for the exclusion of clothing manufactories from the district bounded by 33rd and 59th St. on the north and south and Third and Seventh Ave. on the east and west. The plea is all the more interesting and significant because it comes at a time when a branch of the city government, acting under state legislation of 1914, is engaged in dividing the whole of Greater New York into residence, business and manu-

facturing districts. Such a task is necessarily slow, since it involves the preparation of tentative plans for districting or zoning the city, followed by full opportunity for an expression of public opinion. Conceivably, its execution might be contested, in which case the almost certain ultimate sanction of the highest courts might yet cause long delay.

Compared with all this probable delay, the action of the dozen big merchants, backed by various other powerful interests, seems speedy and efficient, because it sets Feb. 1, 1917, as the date on which these big merchants will begin giving preferences in their purchases to goods manufactured outside the delimited area.

This movement is essentially an appeal from the pocket-book to the pocket-book. It is founded on the sound thesis of preventing another blighted district in New York, with its enormous losses in property values, such as has been created time and again by the northward movement of many classes of business in New York City. Some of these migrations have done no harm except to leave a deserted and blighted district behind them, but the one now in question is believed to cast a blight wherever it extends.

It is certainly time to stop these haphazard movements and try to substitute orderly city development in their place. Where it can be done by coöperation rather than by coercion the results may be more quickly attained, but as a rule the larger interests at stake require both comprehensive and constant supervision and control throughout the whole city by a properly constituted branch of the city government.

An Engineer Returns

An engineer has come into, or partly into, his own again at Seattle. For years R. H. Thomson was not only city engineer, but in large measure he was the administrative government of the city, and that during its most remarkable period of growth. Then malign influences set themselves against him and led him to resign. From that time to this the city council has followed its own notions of city engineering to a marked degree, with some deplorable results. On March 7 Mr. Thomson was elected to the city council, standing next to the highest among the six candidates to fill the three vacancies in Seattle's council of nine members. Undoubedly, Mr. Thomson's great ability and strong personality will again make themselves felt in the city's affairs.

Letters to the Editor

Horizontal Resistance of Piles Under Retaining Walls

Sir—In the ordinary design of a retaining wall founded on piles the number and spacing of the piles to resist the vertical loads imposed are matters of routine design readily comprehended and easily executed. The lateral resistance of the piles to the horizontal thrust of the earth transmitted through the retaining wall is, however, not so well understood.

If a wall is founded on rock, the resistance to sliding is determined by multiplying the vertical component of the resultant by the probable coefficient of friction between the masonry of the wall and the rock foundation. In case this resistance is not sufficiently larger than the horizontal component of the resultant, a suitable key is provided under the foundation, extending into the rock. But for a wall on a pile foundation the piles must furnish the necessary horizontal resistance to sliding, with a suitable factor of safety. For a wall or foundation of which the tangent of the resultant pressure is fairly large the number and spacing of the piles may depend on their resistance to displacement laterally rather than their vertical bearing power.

The required horizontal resistance in each pile just to resist lateral motion might be obtained by dividing the net horizontal force by the number of piles, but the questions now arise: Is this horizontal force resisted equally by each pile, and how much is a pile good for in resisting lateral pressure?

The writer has consulted engineers of wide experience and has explored textbooks, but has been unable to obtain any satisfactory theory or data from tests on the horizontal resistance of piling or the probable distribution of loads. Tests made on piles of different lengths and driven in a variety of soils would probably furnish the most reliable data on horizontal resistance.

CARLTON N. CONNER,
United States Junior Engineer.
Custom House, Cincinnati, Ohio, Feb. 18, 1916.

What Is Invention?

Sir—In connection with your recent editorials and articles on reinforced-concrete patents the following extract, from an address by the late Prof. J. B. Johnson, one-time dean of the engineering school of the University of Wisconsin, will doubtless be of interest:

> Profitable invention must include the use or embodiment of scientific principles with which the untrained artisan is unacquainted. Already our Patent Office is much puzzled to distinguish between engineering and invention. Since engineering proper consists in the solution of new problems in the material world, and invention is likewise the discovery of new ways of doing things, they cover the same field. But an invention is patentable, while an engineering solution is not. Invention is supposed in law to be an inborn faculty by which new truth is conceived by no definable way of approach. If it had not been reached by this particular individual, it is assumed that it might never have been known. An engineering solution is supposed, and rightly, to have been reached by logical processes through known laws of matter and force and motion, so that another engineer, given the same problem, would probably have reached the same or an equivalent result. And this is not patentable. Already a very large proportion of the patents could be nullified on this ground, if the attorneys only knew enough to make their case.

Professor Johnson's address is published *in extenso* in "Addresses to Engineering Students," edited by Waddell & Harrington, pages 25-35. F. H. FRANKLAND.
Lake Charles, La., Feb. 22, 1916.

Snow-Removal Conference Held in New York

Snow-removal methods in cities of from 200,000 up were described and discussed at a conference held in New York City on the evening of Mar. 8, under the joint auspices of the National Highways Association, Society of Street Cleaning and Refuse Disposal of the United States and Canada, Automobile Club of America, Citizens Street Traffic Committee of Greater New York, and the Graduate Course in Highway Engineering at Columbia University. George W. Tillson, who presided, said aptly that if Arthur H. Blanchard picked that date with foreknowledge of weather conditions he deserved to be made chief of the Weather Bureau straightway. Snowstorms occurred both on Feb. 7 and on Feb. 8, and the snow fighters of the Eastern cities were hard at work while their bosses congregated in the Automobile Club of America and explained what the men were doing and how hard it was to get men to work at night.

Seven 30-min. papers were presented, each followed by a short open discussion, the conference closing at 12:30. The following were the speakers: William H. Connell, Chief, Bureau of Highways and Street Cleaning, Philadelphia; John T. Fetherston, Commissioner of Street Cleaning, New York City; George H. Pride, Treasurer, Motor Truck Club; Gus H. Hanna, Cleveland; Leon F. Peck, Superintendent of Streets, Hartford, Conn.; A. E. Kalbach, Deputy Street Cleaning Commissioner, Borough of the Bronx, New York City. The full proceedings of the conference will be published by the National Highways Association.

Until 1912 the removal of snow was not dignified by being regarded as an engineering operation. The old method—and one that still prevails in many centers, especially where money is valuable—was to wait until the snow had ceased falling before inaugurating the counter-attack. Under the present efficient schedule employed by cities of the first class, preparations start with the earliest warning of the approach of a storm, and mobilization of the snow-removal forces commences coincidently with the first flakes.

There are two great classes of removal methods: (1) Those systems and machines that have stood the test of practice; (2) the schemes and devices suggested and offered by inventors. Under the first may be mentioned plowing, loading on trucks and flushing into sewers, and under the second classification occur the various melting devices such as compression boxes, electric grids, asphalt burners and steam pipes (necessitating central-station plants).

The last-named scheme might be theoretically applicable to streets carrying extremely heavy traffic, where the snow must be removed at all costs; but there are two very formidable drawbacks to the use of melting pipes. Maintaining a temperature of 80° on these pipes when the temperature of the surrounding air is zero will certainly cost a lot of money; secondly, only under extremely favorable conditions—and one wonders in what busy streets they are to be found—could the piping be laid beneath the pavement, on account of existing subsurface structures. It is estimated that, in addition to one or more longitudinal mains, laterals would have to be provided every 4 ft. Such a system, were it feasible, would certainly solve the snow-disposal problem in heavy-traffic streets, and some time—maybe in 50 or 100 years—city planners will no doubt provide the necessary piping in the ideal cities of that era.

An interesting special method was described by Mr. Connell. In the Pennsylvania R.R. terminal in Philadelphia the snow is thrown on a car underframe equipped with a number of longitudinal steam pipes. The melted snow falls through into a pan provided with an overflow outlet. This car can be loaded 25 times before the water has to be dumped. Of course this method has limited application in general city work.

The city presenting the hugest snow-removal problem, naturally, is New York, with its 30,000,000 sq.yd. of street surface to be cleared. It is the aim here to employ 18,000 men per shift, with 84 motor plows and 12 tractors, as against a total force of 4,000 men in Philadelphia. New York's snow-removal force is arranged in four divisions: (1) The snow fighting, consisting of employees of the street-cleaning department, with the plows; (2) the snow removal, comprising the contractors; (3) the first reserve, comprising the garbage-collection force with carts; (4) the second reserve, or volunteer organization, comprising the forces and equipment supplied by public-spirited citizens. The first drive is always directed against the snow on congested thoroughfares.

The main problem in snow removal seems to be that of securing and handling labor. Being human, the men do not like to work at night, during a severe storm or in very cold weather. The answer to this is higher pay. At present New York pays its emergency snow fighters 30c. an hour, as against 25c. in normal times (during the general clean-up after the emergency is passed). The additional 5c. an hour is not dazzling enough to tempt a sufficient number of men to endure the hardships entailed by emergency work. In an endeavor to offset this condition a bonus is paid whereby, if a section gang performs its allotted work in a given time, the men are paid 40c. per hour. Deputy Street Cleaning Commissioner Kalbach, of the Bronx, stated that under the present allotment of work it is almost impossible for the men to earn a bonus. This is a condition that calls either for higher emergency wages or for smaller allotments or, perhaps, for both. Against this argument, however, we have Commissioner Fetherston's statement that the cost of snow removal is getting to be too large in New York City. It passed the million-dollar mark this year.

A system deserving of special mention is the use of sewers for snow disposal. This practice is growing in favor wherever it is permitted. In New York where this method has had a thorough tryout, the cost is 3.1c. per cubic yard (exclusive of cost of water), as against 53.3 for contract work during the six winters preceding the inauguration of the sewer flushing (1914-1915), 36.7c. having been the minimum price paid for contract work. The cost in the winter of 1914-1915, for the sewer and contract work in combination, was 12.1c. per cu.yd., and the cost is running along about the same this year.

On Apr. 17, 1914, a snow-removal conference was held in Philadelphia. At that time it was found that nearly every city had its own problem, the modifiers being traffic congestion, adequacy and availablity of sewers, other means of disposal, population, width of streets, and last but not to be neglected, the financial policy of the municipality. In the past two years much has been learned, as the interesting and profitable 1916 meeting proved.

Flat Slab Used at Lackawanna South Orange Crossing

SYNOPSIS—Grade-elevation work utilizing reinforced-concrete girderless-slab construction. Unique solution of station problem. Slabs designed for heaviest train loading. Detailed methods of construction.

The Delaware, Lackawanna & Western R.R. has just completed through South Orange, N. J., a stretch of about a mile of grade changes to eliminate four grade crossings, which involved the construction of 5,000 ft. of earth-fill, three concrete-bridge street crossings and two stations—one at Mountain Station and the other at South Orange. The former is about at the original grade, and the street crossing is carried over the track on a concrete arch bridge. The latter station is novel in that it is built under and around a reinforced-concrete girderless floor bridge that spans the main street of the town and extends for some 400 ft. beyond the street, to accommodate the station structure. It is approached from each end by a new earth-fill.

FIG. 1. THE SOUTH ORANGE TRACK ELEVATION AND STATION OF THE LACKAWANNA RAILROAD

South Orange is on the Morris & Essex division, one of the most heavily traveled suburban lines outside of New York. It has had, up to the present, only two tracks through the village. Increased traffic demanded an express track, so reconstruction was projected about two years ago, involving the enlarging of the right-of-way to accommodate three tracks, the middle one of which is used for inbound express traffic in the morning and for outbound express traffic in the evening. At the same time the grade crossings in the village had to be eliminated. It was decided to do this by elevating the tracks, carrying them on an earth-fill with concrete bridge overcrossings at the streets.

At South Orange station, however, which is immediately alongside the main cross-street of the village, property was so valuable that the purchase of extensive right-of-way had to be reduced to a minimum. For this reason it was decided to incorporate the station with the grade-elevation work, so as to reduce the required ground purchase to the smallest possible. Accordingly, a girderless-slab reinforced-concrete bridge was built, extending, as shown in Fig. 2, from the east side of the transverse street 426 ft. west, including under it the sidewalks and pavement of South Orange Ave., which is a county highway, and the sidewalk approaches to the station, the platforms, motor stands, a heating plant and the station proper.

The railroad had experience with this type of construction in the viaduct 150 ft. wide and 1,000 ft. long approaching the new Lackawanna terminal improvements now under construction at Buffalo. It was adopted at South Orange for its cheapness, the effective architectural treatment it permits, the very shallow floor depth, the absence of vertical projections above the track and the rigidity of the construction. It is stated that two heavy locomotives passing over the structure at high speed produce hardly any vibration and that the rumbling noises common on structural-steel bridges are very much subdued, thus avoiding the usual street-crossing nuisance.

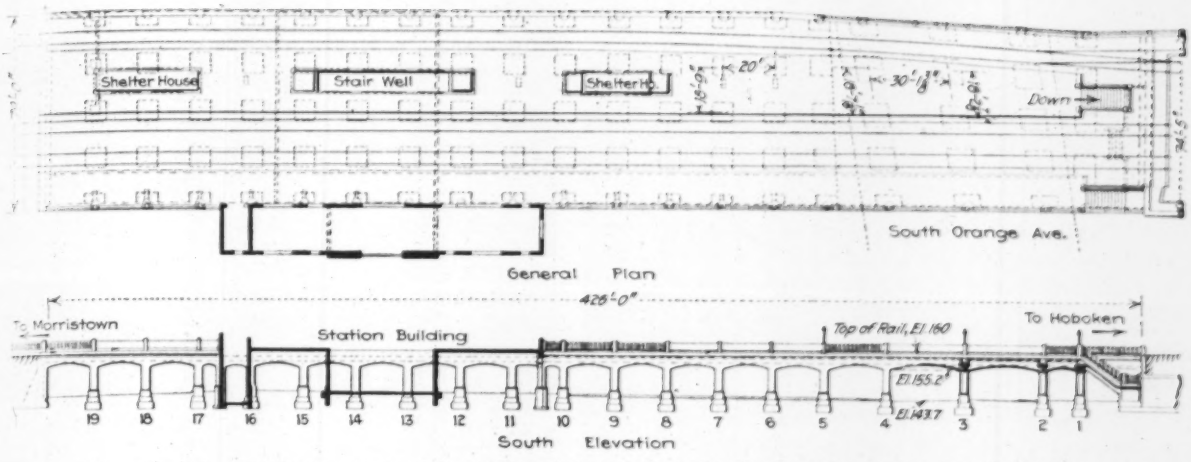


FIG. 2. GENERAL PLAN AND ELEVATION OF THE SOUTH ORANGE GRADE ELEVATION

Details of the crossing are shown in Fig. 2. A view of it is in Fig. 1. It will be seen that it carries three tracks, with two platforms—an island one with shelter houses and an interior one reached from the station proper. On account of property-line irregularities the structure varies from 79 ft. in width at the west abutment to 74 ft. 5 in. at the east abutment. The flat slabs are carried on columns generally spaced 18 ft. 9 in. c. to c. transversely, a spacing dictated both by economy and by the location of the platforms and stairway openings. Longitudinally, columns are spaced on 20-ft. centers, except where the skew of the bridge requires the extension of the span to 30 ft., which makes a number of irregular panels, as shown in Figs. 2 and 3.

The columns for the typical 18-ft. 9-in. by 20-ft. panels are circular in section and 34 in. in diameter. Along the curb line the columns are 36 in., while those in the center of the roadway are 40 in. The slab is 20 in. thick for a typical panel, increased to 26 in. for the roadway span.

Architectural features include a handsome railing, arched fascia girders on the showing faces, colored matt-glazed tile panels at the head of each pilaster, bush-hammering of the exterior surfaces and the use of a

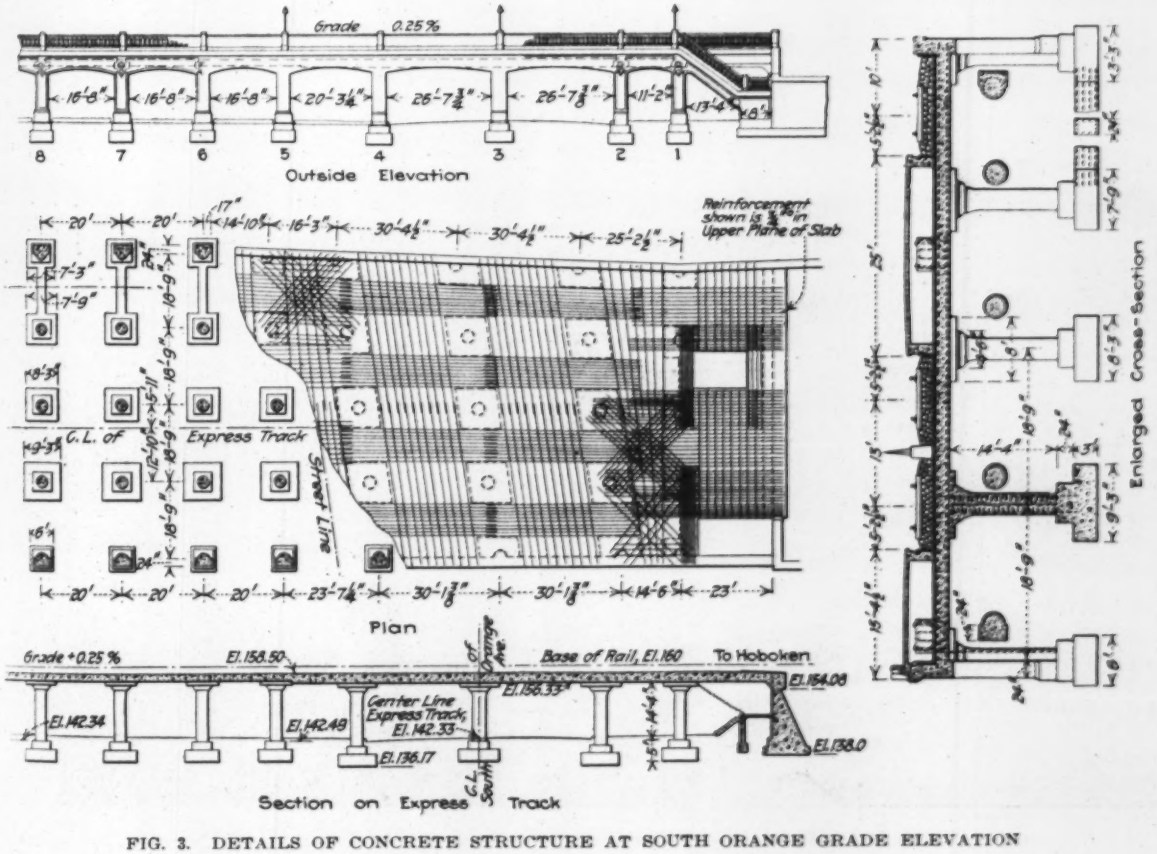


FIG. 3. DETAILS OF CONCRETE STRUCTURE AT SOUTH ORANGE GRADE ELEVATION

dark-red wire-cut brick for the station building. The platform canopies are of structural steel, with concrete roof slabs covered with green tile, similar to that on the waiting-room roof.

The flat-slab floor is on the cantilever flat-slab system, controlled by the Concrete Steel Products Co., Chicago.

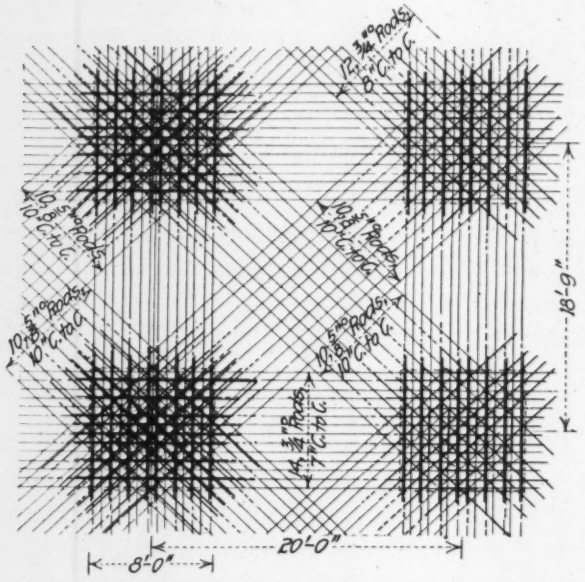


FIG. 4. DETAILS OF THE REINFORCEMENT OF A TYPICAL FLAT-SLAB PANEL

It consists of a four-way reinforcement of a slab with approximately one-half of the rods of each band bent up over the column capitals to provide reinforcement for negative bending moments at these points. The reinforcing details are shown for a typical panel in Fig. 4. The effective depth of the columns is increased by [illegible] panels, also serving to reduce shearing stresses. [illegible] method of design is explained as follows by A. B. C[illegible], Assistant Engineer of the Lackawanna.

The structure was designed to carry two 233-ton Mi[illegible]o engines (four drivers 5 ft. 6 in. c. to c., 60,000-lb. axle lo[illegible]) en train on each of the three tracks. Owing to the high r[illegible]e of speed of the trains across the viaduct, a large live-load im[illegible]pact factor was added, which amounted to 68% of the st[illegible]e live-load and was proportioned in the following ratio: Impact $= \frac{LL \times LL}{LL + DL}$. The maximum negative and positive live-load moments were determined by the theorem of three moments for wheel concentrations of the two engines followed by a trainload of 6,000 lb. per lin.ft. of track over seven panels for both the irregular spans over the avenue and the 18-ft. 9-in. by 20-ft. typical panels. For maximum moments all three tracks were considered loaded. In addition to the longitudinal continuity of the slab over the columns there is a transverse continuity. However, the moments that were computed in the longitudinal direction were distributed transversely in accordance with the method of computing simple beam reactions and the impact factor determined by the formula previously mentioned. Due to the considerable amount of fixedness at the columns and the transverse continuity, $^{12}/_{15}$ of the computed moment was used, thus giving end moments equivalent to $We^2 \div 15$ for determining the amount of steel required over the columns.

Following the method of calculating the negative moment over the columns, the slab at the center of the panel was proportioned for the maximum positive moment, reduced in the same ratio as was the negative moment. The reinforcement required was then distributed among the direct and diagonal bands in accordance with the coefficients of $^1/_{40}$ and $^1/_{60}$ respectively, or a ratio of 3 to 2, as established by the Chicago building code.

The columns were designed as hooped columns, with both spiral and vertical reinforcement to take the maximum reactions due to the conditions of loading, as heretofore described. The footings of the two columns of each bent, under the westbound track, are connected throughout by reinforced-concrete ties to insure a more uniform distribution of the load on these footings. The footings are designed for a soil pressure of 3 tons per sq.ft. on a good gravel subsoil.

The unit stresses used in the design of this work were 650 lb. per sq.in. for extreme fiber compression in the concrete, 16,000 lb. per sq.in. for tension in the steel and 500 lb. per sq.in. for concrete columns exclusive of the steel reinforcement.

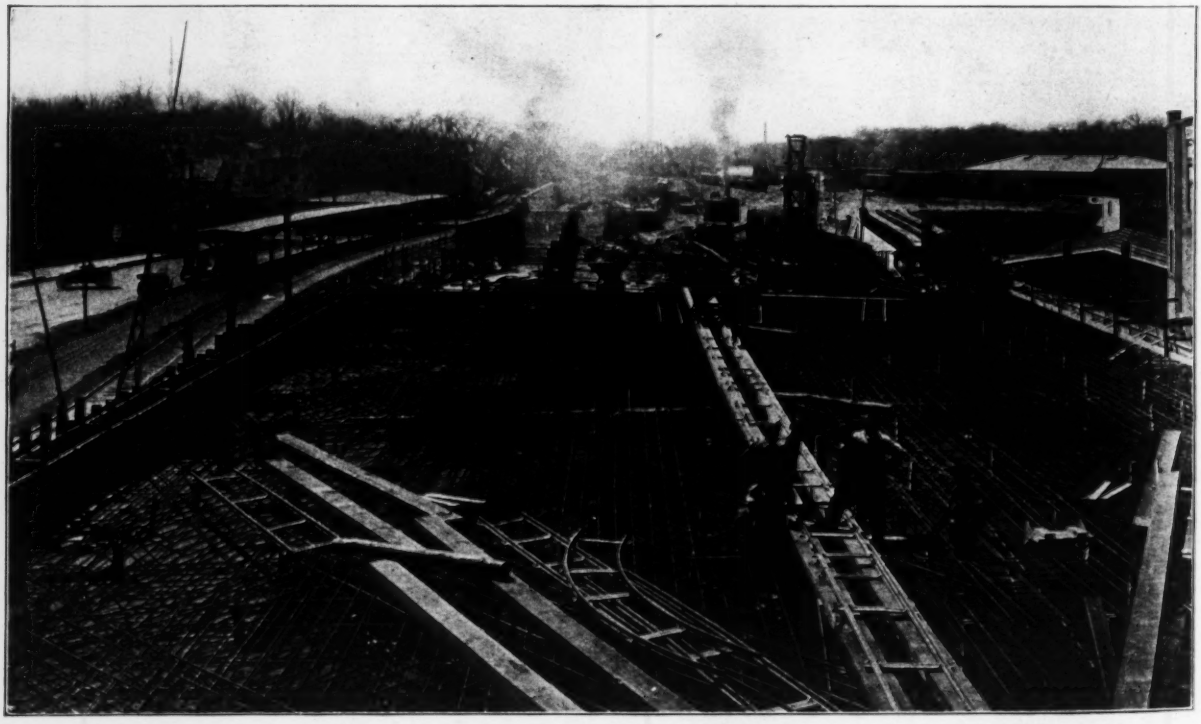


FIG. 5. VIEW OF SOUTH ORANGE FLAT SLAB UNDER CONSTRUCTION

No expansion joints were placed in the bridge proper, but the slab is reinforced for stresses due to temperature variation by bands of reinforcing steel between each row of columns, both longitudinally and transversely. There are ten ¾-in. rounds in each longitudinal band and seven in each transverse band, spaced uniformly between the drop panels and placed in the upper plane of the slab. These are shown in Fig. 3. The bars of the four-way reinforcement that are not bent up over the columns to resist the negative moment are lapped to furnish continuous reinforcement, which provides additional resistance to temperature changes. Where the stair wells occur, the drop panel was extended for half of its width between the corners of the stair wells and the last row of columns, giving a section of increased depth along the sides of the openings.

It was necessary to carry on all the construction of the South Orange improvement while providing for the very heavy suburban commuting traffic. To do this, the tracks were shifted about 30 ft. outside of the center of the right-of-way and the fill brought in from the west. In the construction of the station and crossing at South Orange the columns and their bases were first placed. Then the spiral reinforcement for the columns was securely fastened to the stubs of the column bases and the falsework for the slabs erected. Sheet-metal forms were used for the columns, which were poured to an elevation about 2 in. above the under side of the drop panel. These columns were allowed to attain their initial set before the slab was poured. All steelwork of the slab was then placed, mainly being supported on small 4x4-in. concrete posts or blocks, resting on the floor forms.

An effort was made to get as much of the concrete of the slab poured at once as was practicable. To do this, it was divided into three sections for the full width of the viaduct. The first section, 135 ft. long, commencing from the east abutment, included 5½ panels and contained 886 cu.yd. In order to avoid construction joints in the slabs through any part of the station the last section was made 210 ft. long and covered 10½ panels with 1,110 cu.yd. of concrete. This was all poured in a continuous operation. A mixer was stationed at each end of the work, a ¾-yd. stationary on the approach fill at the east abutment and a ½-yd. mixer on a flat-car that moved in from the west end as the work progressed. Concrete was distributed to the forms on buggies mounted on tracks, such as are shown in the view in Fig. 5.

The slab was waterproofed with three plies of Minwax saturated cloth laid in Minwax hard waterproofing applied hot. Under the platforms this membrane was protected by a 1½-in. layer of concrete, but under the tracks it was protected by two ¾-in. layers of asphaltic mastic mixed with torpedo washed gravel and furnished by the Johns-Manville Co.

The design and construction of the South Orange Improvement were carried out under the general direction of G. J. Ray, Chief Engineer. The station design was made by F. J. Nies, Architect for the railroad company, and was supervised by G. T. Hand, Division Engineer, and W. H. Spiers, Resident Engineer. A. B. Cohen, Assistant Engineer, superintended the reinforced-concrete design, which was approved by A. R. Lord for the Concrete Steel Products Co. The improvement was built by Hyde, McFarlin & Burke, New York City, with a contract to F. B. Hyde of that company for the station.

Illinois Drainage Conference

Land drainage in its various aspects of relation to conservation, sanitation and engineering economics was the subject of a conference held at the University of Illinois, Mar. 8 to 10. Its purpose was to stimulate interest in drainage and flood protection and the reclamation of swamp and overflowed lands in the state. The attendance was smaller than had been expected and consisted mainly of engineers, only a few drainage commissioners and others being present.

The papers were largely of a technical character, but covered a wide range of subjects. One group dealt with surveys, plans and construction. Professor McDaniel, University of Illinois, took up excavating plant and methods. Professor Stewart, University of Minnesota, spoke of the great desirability of standardization of plans, not so much in the interest of the engineer as in that of the landowners and to facilitate the legal proceedings.

Many plans now are too small or too large. They do not show the boundaries of drainage areas or they fail to give bench marks with which other engineers can connect. Where approval of projects by the courts is involved, there is much loss of time in examining plans that are not easily understood. Another important point is that, if the engineer prepares a plan which the landowner can easily comprehend, he tends to make the latter favorably disposed to both the drainage project and the engineer.

River conditions in Illinois were outlined by L. K. Sherman, Illinois Rivers and Lakes Commission, and R. I. Randolph, Chicago. Drainage as a matter of profit and public health was dealt with by Paul Hansen, Illinois Water Survey. The profit is due to cultivation, and improvement in public health is due to the elimination of malarial and mosquito-breeding conditions, as well as to the securing of dry building sites. He instanced one case where the expenditure of $390,000 in drainage work increased property values by $3,000,000 and rendered useless swamp land available for truck farming and healthful suburban districts.

The organization and financing of drainage districts was discussed by J. A. Harman, Peoria. Other lines of discussion related to drainage laws, soil conditions, drainage of railway lands, flood protection and the consideration of river control as a national enterprise. This last applied particularly to the Mississippi Valley.

A special line of thought was that of informing and educating people in the rural districts (who decide upon and pay for drainage work) as to the value of land drainage from economic and sanitary points of view. Dr. Hieronymus spoke of the methods being taken by the University of Illinois to develop the community spirit. E. E. R. Tratman, of *Engineering News*, suggested the advisability of utilizing farmers' institute meetings, Chautauqua meetings and the country press in spreading educational information throughout the rural districts and country towns in such matters of public importance as sanitation, land drainage, good roads, and other engineering projects.

One result of the conference was a movement to organize a drainage section of the Illinois Society of Engineers, open to drainage commissioners, lawyers, and others concerned with drainage work and projects.

Water-Works Chemicals Soar*

By W. F. Monfort†

In a paper presented before the Illinois Section of the American Water-Works Association the effect of the war on prices of chemicals used in water purification to Jan. 22 was discussed. Later developments promise no relief before the end of the current year or before the end of the war.

Under normal conditions buyers of chemicals for water treatment enter but the fringe of the market. The total volume of their purchases is slight as compared with the gross tonnage of lime for the building trades; of sulphate of alumina for textile manufacture and dyeing, tanning of leather and production of alum; of sulphate of iron for dyeing, tanning and the production of colors; of copper sulphate as a plant disinfectant (orchard spray), as the basis of paris green, and in metal plating; of bleaching powder in textile manufactures, as a disinfectant and in chemical processes; of chlorine, now replacing bleaching powder in chemical manufacture and textile bleaching; of soda ash in the manufacture of soap, glass and other chemical-technical products.

Fundamental to production of the sulphates is sulphuric acid; on account of the enormous demand for high explosives—gun cotton, nitroglycerin, picric acid (lyddite, melinite), trinitrotoluol—every factory producing sulphuric acid is running to capacity, with its output contracted ahead. The price has risen about 250%. With this advance market prices of sulphate of alumina have risen. Since mid-February sulphate of iron has doubled in price, with the prospect of shortly paralleling the 250% advance in acid. Copper sulphate has been influenced further by the advance in copper, and wholesale quotations have been steady at almost fivefold the normal price, since England forbade manufacture some five months ago, to maintain an undiminished supply of copper for munitions.

The fundamental process in the manufacture of bleaching powder is the electrolysis of sodium chloride (common salt), yielding chlorine and caustic soda. Both these products are required in the manufacture of picric acid from benzol, which is first chlorinated, then nitrated and finally treated with alkali, to remove chlorine and complete the synthesis:

C_6H_6 to	$C_6H_5 . Cl$ to	$C_6H_2(NO_2)_3 . Cl$ to	$C_6H_2(NO_2)_3 . OH$
Benzol	Chlor-benzol	Chlor-trinitrobenzol	Picric acid
			Trinitrophenol

The significance of this process in affecting prices in this country is illustrated by the fact that a single order placed in January for 1916 delivery will require approximately (not allowing for waste in the several processes) sufficient chlorine to sterilize 4,400,000 million gallons of ordinary filter effluent and a weight of sulphuric acid equivalent to 570 thirty-ton cars of sulphate of alumina or 850 thirty-ton cars of sulphate of iron. These quantities deducted from the available supply of water-works chemicals must have a significant effect upon prices, since they exceed the annual demand of several cities the size of St. Louis.

*Condensed and brought to date by the author from a paper presented in January, 1916, before the Illinois Section of the American Water-Works Association.

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Bleaching powder has advanced to sevenfold its normal price. The price of liquid chlorine has doubled. The difference in advance in these closely related products is due to the fact that under older conditions chlorine was a byproduct of the soda manufacture, with an overproduction for which a market was sought. Established practice for a century has made bleach, prepared by absorbing chlorine in lime, the customary form in which the bleaching agent was shipped. Textile producers are equipped for the use of hypochlorite. Latterly, chlorine, liquefied by refrigeration, shipped in 100-lb. cylinders, has been gaining the approval of textile and pulp manufacturers, while its greater economy and convenience of application make it preferable in chemical processes generally. Of five bleach factories in this country, one has ceased altogether the production of hypochlorite. Two are running to full capacity, but give no quotations and make no deliveries on new contracts. One has been sold to a manufacturer of liquid chlorine, and its output of bleach is diminished. A fifth has increased the output of liquid chlorine, with a corresponding decrease in the production of bleach. The 1916 production of bleach was sold up in November last.

Importations of hypochlorite of lime have practically ceased. In past years the supply from Germany and England was as follows:

BLEACH IMPORTS FOR CALENDAR YEARS

Year	Weight, Lb.	Value per Lb., Cents
1912	72,706,732	0.82
1913	61,695,077	0.82
1914	34,539,934	0.96
1915	7,564,473	1.36

WHOLESALE NEW YORK QUOTATIONS TO MAR. 4, 1916

	Sulphuric Acid (60° Bé.) per Cwt.	Sulphate of Alumina per Cwt.	Sulphate of Copper per Cwt.	Sulphate of Iron per Cwt.	Hypochlorite of Lime per Cwt.
Normal	$0.80@0.85	$0.80@1.10	$4.50@4.75	$0.55@0.60	$1.25@1.35
Jan. 29	2.00@2.50	3.00@4.00	20.00@23.00	0.55@0.60	@13.00
Feb. 5	2.00@2.50	3.00@4.00	20.00@22.00	0.55@0.60	13.00@14.00
Feb. 12	2.00@2.50	3.00@4.00	20.00@22.00	0.55@0.60	12.00@13.00
Feb. 19	2.00@2.50	3.00@4.00	20.00@21.00	0.75@1.00	12.00@13.00
Feb. 26	2.00@2.50	3.00@4.00	20.00@21.00	0.75@1.00	9.50@10.50
Mar. 4	2.00@2.50	3.00@4.00	20.00@21.00	0.75@1.00	10.50@12.50

The present situation with regard to water-works chemicals is: Lime alone is unchanged in price. The 1916 production of sulphuric acid, soda, chlorine and bleaching powder is practically sold up. Contracts for 1917 are now making. Production of the sulphates of alumina, copper and iron is limited and will probably remain so while the great demand for sulphuric acid continues. Water-works purchasers are having difficulty in securing annual contracts at any prices, save as old customers appealing for continuance of orders. Small quantities from limited stocks (the surplus of resting orders) in second hands are available from time to time. The water-works buyer, a minor factor in a world market, is dependent largely upon chance lots and will be compelled to secure what he must have at prices fixed by the world demand, unless he can gain a hearing with producers through long-term contracts at special prices.

Anti-Typhoid Inoculation has been used by the Canadian Pacific Ry. with marked success. Before the practice was adopted there were 320 cases of typhoid fever in 1911 on the Alberta division. Two years or so ago the company offered free vaccination or inoculation to all employees desiring it. Of 24,000 employees, 5,500 were inoculated the first year, and 8,400 the second year, making a total of 13,900 inoculated and 10,100 not inoculated. The number of cases among those who had been inoculated was only two the first year and one the second year, or a total of three, compared with 220 the first year, 70 the second year and 290 for the two years among those who had not been inoculated.

News of the Engineering World

New York Subway Ventilation Plans Investigated

In the early summer of 1915 an active campaign was conducted in New York City against the plans to ventilate the new subways through open gratings in the sidewalks. It was alleged that the air escaping from these openings was foul, germ-laden and a serious menace to health. It was further alleged that pedestrians avoid walking on the open gratings and that this injures the value of the abutting property for show-window purposes. The newspapers took an active part in the campaign and published various suggestions from engineers and others as to alternative methods of ventilation in place of the open gratings in sidewalks.

After hearing protests from property owners, citizens' associations, etc., the Public Service Commission created a board of engineers to investigate and report, with recommendations, on the question of ventilation of the subways. The board was made up of William Barclay Parsons, S. L. F. Deyo, J. Vipond Davies, Lewis B. Stillwell and Alfred Craven, Chief Engineer of the Public Service Commission. The report of this board, dated Feb. 24, has just been made public. The conclusion of the board is that ventilation through sidewalk gratings is the least objectionable and most practicable method for ventilation of the new subways.

The necessity for ventilation of the subways arises chiefly from the enormous amount of heat discharged into them from the electric energy used in the propulsion of the trains. Some heat also is discharged in the operation of the lighting system and from the bodies of the passengers traveling in the subway. The great bulk of the heat in the subway, however, is due directly to the energy used in the movement of the trains. Such difficulties from excessive temperature of subway air have not been found in any other cities where subways are operated, because in no other city having an extensive subway system is the summer temperature as high as in New York City or are the weight, speed and number of trains such as to discharge an equally large amount of heat.

Besides this, the plans for the original subways were violently criticized before construction on the ground that the foul water and gas in the earth would leak into the subways and convert them into sewers. In order to meet this popular criticism extra precautions were taken in waterproofing the subway structure by layers of felt and asphalt. While the waterproofing was successfully effected, the material used acted as an excellent non-conductor of heat, to obstruct the transmission of the interior heat of the subway into the earth. In building the new subways waterproofing is being used only where it is necessary.

The popular belief is that the subway air is foul, is laden with disease germs and is dangerous to health. This belief has been fostered by sensational newspaper articles. Shortly after the subway was opened, in 1905, elaborate tests were made by Dr. G. A. Soper and Dr. Charles F. Chandler, two eminent authorities on chemistry and sanitation. The report of these experts showed that the air of the subway was at that time practically the same in carbonic acid content as the air of the street and was purer than the air of most public assembly halls. Similar thorough tests on the air of the subway have been made by G. L. Lucas, under the direction of the Board of Engineers, and have confirmed the results obtained by Dr. Chandler and Dr. Soper a dozen years ago. The tests, extending over three months, showed the average oxygen content of air in the street at 20.6% and of air in the subway at 20.64%. The carbonic acid gas content in parts per 10,000 varies from 4 to 5 in air in the street, and an average of all the tests in the subways was 6.2 parts. Tests of the bacteria in street air and subway air showed an average of 255 bacteria per cubic meter for street air and 219 bacteria in subway air.

These figures, which are brief summaries of results given in the report in much greater detail, show that the only objectionable thing in the subway air is its excessive heat in the summer months. When these facts were established in 1905, the Rapid Transit Commission installed apparatus to change the air in the subway more frequently, in order to carry off more rapidly the excessive heat. Ventilating openings were introduced in the walls of the subway between stations, which were connected by galleries with open gratings in the street sidewalks. The piston action of the trains in the subway, as well as the natural ventilation currents occurring when the temperature in the subway is higher than that of the street air, produces currents of air through these gratings.

The Board of Engineers has studied the objections made to the ventilating gratings in the sidewalks and finds that some of the property owners who have protested against these gratings have themselves installed gratings for private purposes, such as ventilating heated basements, boiler rooms, etc. Tests showed that from some of these gratings inserted in the sidewalk by private property owners air was being discharged at temperatures far above the street temperature, in one case reaching a maximum of 184° F. The temperature of the air issuing from the average subway opening, on the other hand, is only 5° to 7° above the temperature of the outside air. The velocity of the air currents from the private gratings in the sidewalks ranged from 1 mi. to 12 mi. per hr., while the air issuing from the subway gratings even when trains were passing, had a velocity of only 1.17 mi. per hr.

The Board of Engineers held public hearings at which property owners and their representatives, including some engineers, appeared to protest against the sidewalk gratings and to urge that some other method of ventilation should be adopted. The suggestions for alternative methods of ventilation are grouped by the board into four classes, as follows: (1) Chemical treatment of the air; (2) control of air current from subways by closing station entrances; (3) ventilation openings elsewhere than

in the sidewalk, especially use of chimneys in private buildings for forced-draft exhaust; (4) refrigeration.

In discussing these plans for ventilating the subway air the suggestion of chemical treatment is answered by the fact that the subway air is for all practical purposes already as pure as the street air. Control of subway air currents by placing revolving doors in station entrances would be impossible with enormous crowds.

The third suggestion, discharging air from the subway elsewhere than through sidewalk gratings, is discussed at great length by the board. The use of chimneys along the route for ventilation is discussed sufficiently to show its utter impracticability. The enormous volumes of air necessary to be discharged from the subways are so great that it would destroy the chimneys' usefulness for power purposes, were the subway air to be discharged into them. To ventilate the subway through shafts with a system of blowers would cost, for the section between Brooklyn Bridge and 96th St., more than $4,000,000 to install; and the annual cost of operation would represent the interest on about $10,000,000, or a total capitalized cost of $14,000,000, which is equivalent to about $2,000,000 per mile of this section of the subway, and this sum approaches the original cost of construction. This estimate, moreover, does not include the very heavy cost of the real estate, easements, etc., that would have to be acquired to construct such ventilating shafts.

Artificial refrigeration to cool the subway air has been exhaustively examined by the board. Careful measurements have been made of the amount of heat liberated in the subway, which is as high as 2,380 B.t.u. per hour during rush-hour traffic and 6,600 B.t.u. per hour per foot of platform at express stations. The estimates prepared by advocates of refrigeration for cooling the subway air have been investigated by the board, which finds that the estimates do not provide sufficient plants for ventilation purposes, which ventilation is necessary in any event on account of the great crowds using the subway. The refrigerating plant proposed, moreover, would lower the temperature only 2 or 3° F. The cost of the plant and its operation would be out of all proportion to the benefit gained.

The final conclusions of the board are as follows:

That of the various plans proposed for ventilation which depend primarily upon fans or blowers there is none that can be regarded as practical, efficient and safe which does not involve, on the one hand, prohibitive cost, or, on the other, inconvenience and annoyance to the public using streets and sidewalks—more serious, in our judgment, than any annoyance resulting from the use of the contemplated sidewalk gratings.

That in the opinion of our committee the natural method of ventilation by the piston action of trains, with intake and discharge openings of large area and supplemented by fans for emergency use, is the most effective method which can be applied at practicable cost and provides the maximum degree of safety against unforeseen effects of interruption of traffic due to accident.

That in subways constructed with more or less continuous grating openings along the length of the structure the natural method of ventilation is adequate without auxiliary mechanical installation. That in the application of this natural method the location of the gratings required should be closely studied, in order to minimize their occupation of sidewalk area at any one point, and that when care has been exercised in this matter such gratings are less objectionable than any practicable alternative method of ventilation which would secure for the public using the subways equal safety and comfort.

That experiments made in the Fourth Ave. subway point to the conclusion that minor modifications in the subway structure may be advisable, such as closing some of the openings in the central partition wall and possibly extending partition walls through stations.

Panama Slide Commission Presents Its Report

The preliminary report of the commission appointed by President Wilson, Nov. 18, to visit the Panama Canal and report upon its slides has just been made public. Dr. Charles R. Van Hise, President of the University of Wisconsin, was chairman of the commission, and among the well-known engineers who were members were Gen. H. L. Abbott, R. C. Carpenter, Arthur P. Davis, John R. Freeman, J. F. Hayford and H. F. Reid.

The commission believes that, after the present difficulties have been overcome, navigation through the canal is not likely again to be seriously interrupted. Nearly all the important movement of sliding ground is concentrated within about one mile in length, where Culebra Cut is the deepest. About 9,000,000 cu.yd. will have to be removed between the two Culebra slides, and the dredges can remove about 1,000,000 cu.yd. a month. The commission believes, however, that the time is probably not far off when the canal may again be opened for navigation, as the slower movement of the slides as excavation progresses will enable the dredges to keep pace with them while the canal is in use. The commission does not find that the great mass of rock in Gold Hill and Contractors' Hill has shown any signs of movement.

As a means of lessening trouble with slides, the commission recommends the covering of slopes with vegetation, the closing of cracks by earth-fills, a system of surface and tile drainage and careful surveys of ground adjacent to the canal to determine with accuracy when any sliding movement starts. The commission's final report will not be ready until April.

Military Roads and Bridges Described to Engineers

The construction of military roads, bridges and ferries and the selection of fords were described, Mar. 13, by Capt. S. L. Godfrey, Corps of Engineers, U. S. A., at the fifth lecture in the series arranged by the national engineering societies in New York City. The great importance of time and the subordination of cost in such work were emphasized at the outset.

The usual road work is in improving existing lines, although new roads around military obstacles may be made. Grades may be kept up to 6% for transportation, and those of 10 to 15% are not impossible for maneuvers. Earth roads are the type to be expected in American operations, and these give good service if ruts are kept filled and side ditches open. In poor ground, rock and corduroy are satisfactory for wagons, but are bad for motor trucks. Culverts are kept down to the simplest pipes.

Rivers may preferably be forded, except for continuous travel. A maximum depth of 3½ ft. can be taken by infantry, 4½ ft. by cavalry and 3 ft. by wagons—if the banks are low, bottom hard and current moderate. The hydraulic conditions need to be studied in selecting a ford, for a diagonal bar may give a crossing where there is no direct passage. Fords are marked by range lines and lights. Marshy banks and poor bottom may be improved.

Ice may be used as a temporary bridge, when 3 in. will support a few men; 4½ in., a few cavalry troopers;

in., wagons and guns; and 9 in., the heaviest army loads. Bridges have their positions fixed by tactical considerations, but the type is selected by the engineers. Pontoon bridges are usually first thrown across streams of size, but should be replaced by trestle bridges later, so that the pontoons may be released for use in front. The present American pontoon equipment was designed by a board of engineers just before the Civil War, incorporating various features seen abroad and arranging for mule-wagon transportation. Their great success was demonstrated in 1861-65. Two designs are used—one all wood and one of wood frame and canvas cover, the latter type being light enough so that it may be carried along with an advance cavalry column. Each engineer battalion carries wagon trains for 1,900 ft. of bridge. The mules are an important factor and have to be trained for the service; reliance is not placed on the quartermaster department for transportation. Motor cars may be utilized at times, but usually they cannot approach the banks and mules have to be used. The steel and aluminum boats now used abroad are not liked here.

Vermont Society of Engineers Holds Annual Meeting

The Vermont Society of Engineers held its fourth annual meeting at Burlington on Mar. 9. The heaviest snowstorm of the winter, which blockaded the railways, interfered with the attendance, but about 40 members were present. The total membership of the society was shown by the secretary's report to be 118. Papers were read on the "Manufacture of Hydrated Lime in Vermont," by G. C. Thompson, Assistant Superintendent of the Vermont Marble Co.; on the "Waterproofing of Concrete," by Prof. C. W. Dix, University of Vermont; and on "Causes of Failure in Concrete Work," by F. O. Sinclair, City Engineer of Burlington.

The officers elected for the ensuing year are: President, H. M. McIntosh, Burlington; vice-president, B. M. Hayward, Montpelier; director, F. W. Denison, St. Albans; secretary, G. A. Reed, Montpelier; treasurer, Prof. A. E. Winslow, Northfield.

At the annual dinner in the evening the retiring president, A. C. Grover, City Engineer of Rutland, reviewed the past history of the society. "The Engineer's Opinion on Public Questions" was the subject of an address by Charles Whiting Baker, editor-in-chief of *Engineering News*.

The society's Committee on Public Policy reported a proposed code of ethics, which it was voted should be sent out to the members for letter ballot on its adoption. The code is substantially identical with that adopted in 1911 by the American Institute of Consulting Engineers and published in *Engineering News* of June 29, 1911. It is as follows:

It shall be considered unprofessional and inconsistent with honorable and dignified bearing for any member of the Vermont Society of Engineers:

1. To act for his clients in otherwise than in a trustworthy manner or to accept any other remuneration than his direct charges for services rendered his clients, except as provided in clause 4.

2. To accept any trade commissions, discounts, allowances or any indirect profit or consideration in connection with any work which he is engaged to design or superintend, or in connection with any professional business which may be intrusted to him.

3. To neglect informing his clients of any business connections, interests or circumstances which may be deemed as influencing his judgment or the quality of his services to his clients.

4. To receive, directly or indirectly, any royalty, gratuity or commission on any patented or protected article or process used upon work in which he is retained by his clients, unless and until receipt of such royalty, gratuity or commission has been authorized in writing by his clients.

5. To offer commissions or otherwise improperly solicit professional work either directly or by agent.

6. To attempt to injure, directly or indirectly, the professional reputation, prospects or business of a fellow-engineer.

7. To accept employment by client while the claim for compensation or damages, or both, of a fellow-engineer previously employed by the same client and whose employment has been terminated, remains unsatisfied, or until such claim has been referred to arbitration, or issue has been joined at law, or unless the engineer previously employed has neglected to press his claim legally.

8. To attempt to supplant a fellow-engineer after definite steps have been taken toward his employment.

9. To compete with a fellow-engineer for employment on the basis of professional charges, by reducing his usual charges and attempting to underbid after being informed of the charges named by his competitor.

10. To accept any engagement to review the work of a fellow-engineer for the same client, except with the knowledge or consent of such engineer or unless the connection of such engineer with the work has been terminated.

New Business Manager for "Engineering News"

Frederick P. Burt, who was connected with *Engineering News* from 1887 to 1905 and was for 13 years business manager of the Engineering News Publishing Co., has returned to *Engineering News* as its manager. Mr. Burt was educated in Canada, and his early professional work was done in that country in the field of civil and sanitary engineering and surveys for the Canadian Government. Since his resignation from *Engineering News* in 1905, Mr. Burt has been the publisher of the *American Architect* and in more recent years has been business manager of the M. C. Clark Publishing Co., Chicago.

All New York State Highway Bridges Under Scrutiny

The study of New York State highway bridges, as to their safety and adequacy under present-day traffic, for a year has been in the hands of a special committee of the Legislature (C. O. Pratt, Cambridge, N. Y., chairman) and a coöperating committee of the New York State Automobile Association (composed of G. A. Ricker, Consulting Engineer, Albany; F. A. Hermans, Troy, Bridge Engineer of the State Highway Department; and J. L. Baker, Middleburgh). The committee was given $6,000 to support its investigation.

A preliminary progress report has just been made to the legislature, showing the conditions disclosed by a circular tour over typical state routes—through Cobleskill, Oneonta, Binghamton, Elmira, Watkins, Geneva, Auburn, Syracuse, Utica, Little Falls, Amsterdam and Schenectady. In all 218 bridges were examined—or one for each 2.18 mi. of road (which is to be compared with the known figures of 34,000 bridges in the state, or one to 2.25 mi. of highway). There were seen 119 of 5- to 20-ft. length, 58 of 20- to 50-ft., 28 of 50- to 100-ft., and 13 of over 100-ft. span. The examination showed 27 of 3 tons capacity or less, 16 of 5 to 8 tons, 13 of 8 to 10 tons, 1 of 10 to 14 tons, 125 of 15 tons, and 9 of over 15 tons capacity. In general, the shorter bridges have the greater capacities. The committee reports that the

present capacity required by traffic is four times that demanded in 1900 and that all bridges should be built for 15 or 16 tons load.

The committee has not presented a plan for the rebuilding, which would cost $30,000,000 and at present progress would occupy 40 years; a request has been made for continuing the work of the committee, however, as two thirds of its original appropriations of $6,000 is still unexpended.

A Railway Creosoting Plant will be built by the Boston Elevated R.R. for treating crossties. G. B. Shipley, of Pittsburgh, will design the plant and superintend its construction.

The Division St. Bridge Collapse, Spokane, Wash., has become practically a closed case, through the settlement of the last damage claims. The claims paid, or to be paid, by agreement total about $70,000, according to the "Spokesman-Review." This amount covers 5 deaths and 17 cases of personal injury. The city pays two-thirds of the amount, the Washington Water Power Co. one-third. No further action in investigating the cause of the failure is expected.

The Railway Builders' Strike on the Alaska Government railroad lasted from Feb. 7 to Mar. 7. The original strike was by the track layers, who demanded an increase in pay from 37½c. an hour to 50c. an hour. The strike was called off under an agreement that a wage scale should be fixed in conference between the Alaskan Engineering Commission and a committee representing the workmen's union. Any increase in wages will be made retroactive from the date of resumption of work.

Steam Invades the Home of Water Power—A steam power station of 60,000-kw. capacity is now under construction in Buffalo, N. Y., for the Buffalo General Electric Co. The installation will include three 20,000-kw. turbo-generators with five boilers of approximately 13,000 sq.ft. heating surface each, the usual steam and electric auxiliaries, coal-handling apparatus and trestle, and intakes and discharges for the condensing system. The Stone & Webster Construction Co., Boston, is the constructing engineer.

Garbage Grease at the High Price of $6.26 per 100 lb. will add an estimated $30,000 to the revenues of the Cleveland municipal garbage-reduction works for the next six months. Three bidders offered the price named, and three others put in lower bids. The price received a year ago was $4.40. The recent bid is the best one Cleveland ever received for garbage grease. The high price is said to be caused largely by the active demand for glycerin for use in the manufacture of explosives and for red oil for dyestuffs. This is interesting in view of the belief expressed at Cleveland a year ago (see "Engineering News," Mar. 18, 1915) that the European War would cause a slump in the price of grease.

The Pennsylvania Bureau of Township Highways has divided the state into five districts, and five men have been promoted from the ranks to act as assistant engineers in charge of these districts, as mentioned in the "Personals" columns. The object of this change is to facilitate the work of the bureau and to bring it and the State Highway Department into closer touch with the township supervisors and the public. Under this arrangement, surveys for improvements contemplated by the township supervisors can be made by the engineer in the district, without having to wait for a man to be sent out from the Harrisburg office. The formation of these districts and the several promotions are effective Apr. 1.

Two 14-Ft. Reinsch-Wurl Sewage Screens are to be installed at the foot of the Dyckman St. sewer, Borough of Manhattan, New York City. The screens will be located in a brick building 35x45 ft. in plan, located adjacent to the 5x9-ft. combined sewer at about 60 ft. distance from the mouth of the sewer. The contract has been let, and work is in progress on the foundation of the building and on the portion of the outlet sewer between the building and the water which is to receive the screened sewage. Contract for the superstructure of the building and for the machinery will be let. The estimated cost of the first installation is $40,000 and of the entire ultimate plant is $75,000. The annual operating expense is estimated at from $2,500 to $3,000. It is expected that the plant will be in operation by Jan. 1, 1917. Charles E. Gregory is chief engineer of the bureau of sewers for the Borough of Manhattan, and John H. Weinberger is assistant chief engineer. Walter Cohen is assistant engineer in charge of the design, and G. L. Christian of the construction of the screening plant.

PERSONALS

Mr. Albert J. Gardetto, of Passaic, N. J., has been elected Vice-President of the Old Colony Construction Co., Boston and New York City.

Mr. W. M. Vandersluis, Signal Engineer of the Illinois Central R.R. at Chicago, has been appointed Consulting Signal Engineer of the Central of Georgia Ry., with headquarters in Savannah, Ga.

Mr. E. P. Worden, M. Am. Soc. M. E., formerly Manager of the Fred M. Prescott Steam Pump Works, Milwaukee, has been appointed Chief Engineer of Henry R. Worthington, Harrison, N. J.

Mr. Howard W. Holmes, Assoc. M. Am. Soc., C. E., formerly State Highway Bridge Engineer of Oregon, has opened an office as Consulting Engineer at 815 Northwestern Bank Bldg., Portland, Ore.

Mr. George Kingdon Parsons, M. Am. Soc. M. E., has located his main offices in the Equitable Building, 120 Broadway, New York City. He will continue his office in the Riggs Building, Washington, D. C.

Mr. W. Walley Davis, M. Am. Inst. M. E., Superintendent of the byproduct coke ovens of the Semet-Solvay Co. at Steelton, Penn., has been made Manager of the Byproducts Coke Corporation, Chicago, Ill.

Mr. C. P. Bowie, Assoc. M. Am. Soc. C. E., formerly Engineer of the Associated Pipe Line Co., San Francisco, is now Petroleum Engineer for the United States Bureau of Mines, with headquarters in San Francisco.

Mr. Ellis Soper, M. Am. Soc. M. E., President of the Soper Engineering Co., Chattanooga, Tenn., has been appointed Chief Engineer of Design and Construction of the plant of the Cuban Portland Cement Co., Havana, Cuba.

Mr. W. A. Van Duzer, Assoc. M. Am. Soc. C. E., Assistant Engineer of the Pennsylvania State Highway Department in charge of District No. 6, with headquarters at York, has been transferred to Scranton to succeed Mr. Tebbs, promoted.

Mr. Frederick T. Crane, City Engineer of Orange, N. J., for the past 22 years, has been nominated member of the New Jersey State Department of Health to succeed Mr. M. N. Baker, Montclair, N. J., whose term of office will expire on July 1.

Mr. Edward C. Sherman, M. Am. Soc. C. E., of Rourke & Sherman, Consulting Engineers, Boston, Mass., has been elected Secretary of the Old Colony Construction Co., Boston and New York City. He will continue his consulting practice in Boston as heretofore.

Messrs. Paul P. Whitham, Assoc. M. Am. Soc. C. E., and Llewellyn Evans, Assoc. Am. Inst. E. E., have organized the Industrial Engineering Co., with offices in the New York Block, Seattle, and at 725 Commerce St., Tacoma, Wash. The company will engage in consulting practice.

Mr. William H. Becker, formerly in the employ of the Arizona Eastern Railroad Co., at Globe, Ariz., has been engaged as consulting engineer for the Gila County Road Department in the construction of roads under a $350,000 bond issue. He will make his headquarters in Globe.

Mr. P. P. Bourne, M. Am. Soc. M. E., formerly Chief Engineer of the Blake & Knowles Steam Pump Works, East Cambridge, Mass., is again associated with the International Steam Pump Co. in connection with special engineering work located at the company's main office, 115 Broadway, New York City.

Mr. R. E. Harrison, recently Assistant City Engineer of Grand Rapids, Mich., and resident engineer of construction during the building of the filter plant of that city, resigned his position on Mar. 1 to become Vice-President and Manager of the L. A. Boulay Co., Civil and Sanitary Engineers, Toledo, Ohio.

Mr. Joseph C. Allison, Assoc. M. Am. Soc. C. E., until recently Assistant General Manager and Chief Engineer of the California Development Co., Calexico, Calif., has resigned to engage in consulting engineering work at Calexico. He has been connected with the California Development Co. for nearly 15 years.

Mr. George M. Basford, M. Am. Soc. M. E., recently Chief Engineer of the Railroad Department of Joseph T. Ryerson & Son, New York City, is President of the newly organized Locomotive Feed Water Heater Co., 30 Church St., New York City. Mr. Basford will also form a new concern to handle advertising accounts of railway-supply companies, to be known as the G. M. Basford Co.

Mr. P. M. Tebbs, Assistant Engineer of the Pennsylvania State Highway Department, who has been in charge of District No. 12, with headquarters at Scranton, has been promoted to the position of Engineer of Construction. He will fill the vacancy caused by the resignation of John T. Gephart, Jr., and will have headquarters at Harrisburg.

Mr. W. H. Stewart, for the past 15 years Surveyor to Lloyds Register of Shipping in San Francisco, has resigned to engage in business as a consulting engineer and marine surveyor, with offices at 260 California St., San Francisco, Calif. He will give special attention to the supervision of design, construction and repairs of vessels and their machinery.

Mr. Fred R. Hesser, for the past three years Assistant Engineer of the Kansas State Board of Health, has resigned to become Manager of the Universal Concrete Construction Co., Kansas City, Kan. Mr. Hesser graduated from the University of Kansas in 1910. He has served for two years as City Engineer of Beloit, Kan., and County Surveyor of Mitchell County and one year as Assistant Highway Engineer of Kansas.

Messrs. Harrison W. Latta, M. Am. Soc. C. E, and J. Kinter Roberts, have formed a partnership under the firm name of Latta & Roberts, with offices at 363 Drexel Building, Philadelphia, Penn., to engage in heavy contracting, such as foundations, excavation, piledriving, wharf and trestle building and subaqueous work. Mr. Latta was formerly President of the Latta & Terry Construction Co., Philadelphia, and for the past five months has been a member of the staff of the Association of American Portland Cement Manufacturers.

Mr. R. H. Thomson, M. Am. Soc. C. E., has been elected one of the three new members of the City Council of Seattle, Wash. Mr. Thomson for many years has been in entire charge of the design and construction of the municipal improvements of Seattle, including the city water-supply. He was City Engineer of Seattle from 1892 to 1911; Chief Engineer of the Port of Seattle during 1911 and 1912; Chief Engineer of Strathcona Park, Victoria, B. C., from 1912 to 1915; and recently has practiced as a consulting engineer in Seattle.

Mr. Joseph B. Baker, since 1912 Assistant Supervisor of the Pennsylvania R.R., at Newport, Penn., has been promoted to the position of Supervisor, Office of the Assistant to General Manager. Mr. Baker entered the service of the Pennsylvania in 1905 as rodman in the construction department. The following year he was transferred to the maintenance-of-way department and in 1909 was made transitman at Altoona, Penn. He was advanced to Assistant Supervisor at Watsontown, Penn., in 1910 and the next year was transferred to Newport.

Mr. C. H. Johnson, formerly Engineer of Construction of the Nashville, Chattanooga & St. Louis Ry., has resigned to become Superintendent of the Gould Contracting Co., Nashville, which is constructing various bridges and viaducts for the railroad. Mr. Johnson graduated from Vanderbilt University in 1890 and entered the engineering department of the railroad as rodman, rising through various ranks to the position of Engineer of Construction in 1910. He designed the Chattanooga Creek culvert and the Running Water viaduct and was in charge of grade reduction on the main line.

Messrs. Charles E. Parsons, M. Am. Soc. C. E., and Guy C. Simpson, have organized the firm of Parsons & Simpson, Engineers, with offices at 61 Broadway, New York City and San Antonio, Tex., for the purpose of carrying on a general engineering practice in the United States and Mexico. The firm is prepared to make preliminary surveys and investigations, to furnish plans and estimates and to supervise construction. Mr. Parsons has recently been President of the Ambursen Co., New York City, and both members of the firm have had wide engineering experience.

Mr. Washington B. Lewis, Assoc. M. Am. Soc. C. E., has been appointed Supervisor of the Yosemite National Park, California. Mr. Lewis graduated from the Engineering Department of the University of Michigan in 1907 and since that time has been a member of the United States Geological Survey. He was furloughed for survey work with the first and second National Geographic Society expeditions in Alaska, and in 1911 went to Argentina, where he was engaged for four years in making studies and surveys in connection with the investigation of the industrial possibilities of northern Patagonia, for the Government of Argentina.

Mr. B. J. Dalton, M. Am. Soc. C. E., Assistant District Engineer of the Fifth District, Valuation Division, of the Interstate Commerce Commission, located at Kansas City Mo., has been appointed Chairman of the Valuation Committee of the Missouri, Kansas & Texas Ry., with headquarters at Parsons, Kan. Mr. Dalton succeeds Mr. S. B. Fisher, M. Am.. Soc.. C E., who has been assigned to other duties. Mr. Dalton graduated from the University of Kansas in 1890 and spent practically all of his time in railroad work up to 1904, when he was appointed City Engineer of Lawrence. From 1906 to 1911 he was Professor of Civil Engineering at the University of Kansas and resigned to take the position which he has just given up.

Mr. Ewing D. Sloan, Valuation Engineer of the Nashville, Chattanooga & St. Louis Ry., has been appointed Engineer of Construction of that railroad, which position he will hold in addition to his present duties. Mr. Sloan is a graduate of Washington and Lee University. He has been previously Assistant Engineer of the Virginian Ry., in charge of projected location, and employed in the construction departments of the Minneapolis & St. Louis R.R., Iowa Central lines and the Great Northern Ry. More recently he was made Chief Engineer of the Tuscaloosa Mineral R.R. and then became connected with the Louisville & Nashville R.R. in charge of new construction in eastern Kentucky.

Mr. E. J. Pearson, Vice-President of the Texas & Pacific Ry. at New Orleans, La., has been appointed Vice-President of the New York, New Haven & Hartford R.R., with headquarters in Boston, Mass. He will act as general assistant to President Elliott and will have charge of all matters relating to construction, operation and maintenance. Mr. Pearson graduated from Cornell University in 1883. He has had a large experience in construction and operation, particularly in terminal work. He had entire charge of the construction of the Wisconsin Central Terminal, while in the employ of the Northern Pacific Ry. Later he was for five years in charge of building the Puget Sound extension of the Chicago, Milwaukee & St. Paul Ry. While on a trip East he made a thorough examination of the wharf and dock properties of the New Haven road from New York to Boston, so that he might be able to help in the construction of similar facilities at Duluth and Puget Sound. For four years Mr. Pearson was Vice-President, under B. F. Bush, of the Missouri Pacific System, during which period he did much work in rebuilding and developing the line and in introducing economical operating methods. He has been engaged during the last year on the new terminals of the Texas & Pacific at New Orleans.

OBITUARY

Walter B. Murdoch, an engineer, until recently interested in mining in Mexico, died in New York City, on Mar. 12. He was born in Washington, D. C. For many years Mr. Murdoch had been engaged in building a deep drainage and mining tunnel 12 mi. long, to give access to a chain of gold and silver mines in the districts of Pachuca, Real del Monte and El Chico, State of Hidalgo, Mexico.

Theodore Voorhees, M. Am. Soc. C. E., President of the Philadelphia & Reading Ry., died at his home in Elkins Park, Philadelphia, on Mar. 11. He was born in New York City in 1847 and was a graduate of Columbia College and Rensselaer Polytechnic Institute. He entered the service of the Delaware, Lackawanna & Western R.R. in 1869 and four years later became Superintendent of the Syracuse, Binghamton & New York R.R. Later he was in charge of the transportation department of the Delaware & Hudson Canal Co. and General Superintendent of the New York Central & Hudson River R.R. He became First Vice-President of the Philadelphia & Reading in 1893 and was elected President in 1914, after the death of George F. Baer.

Samuel S. Greeley, a well-known civil engineer and the oldest alumnus of Harvard University, died in Winnetka, Ill., on Mar. 8, at 92 years of age. He was a member of the Harvard Class of 1844 and in the following year entered Rensselaer Polytechnic Institute, graduating from that institution in 1846. He did considerable railway location and construction work in New York, Vermont and Virginia. In 1853 he entered into a land-surveying business with Mr. Hanchett, in Chicago, which was continued until last year, when the firm name was changed to Greeley, Howard & Norlin Co. He was appointed City Surveyor of Chicago in 1855 and served for one term. He obtained a license for the Nicholson Block Paving Co., of Chicago, and laid in that city a considerable amount of the block pavement manufactured by that concern. Later he became interested in the manufacture of threshing machines. In the late 50's Mr. Greeley was appointed Superintendent of the Chicago, Burlington & Quincy R.R., which position he held for a short time In 1879 he took into the firm as partners the late Frederick Greeley, the late Gustav H. Carlson and Sylvester N. Howard, and afterward his son, Morris L. Greeley. He was one of the four organizers, in 1857, of the Harvard Club of Chicago, and was later its President. Mr. Greeley was the grandfather of Samuel A. Greeley, Assoc. M. Am. Soc. C. E., Sanitary Engineer, Chicago.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 21-23. Annual meeting in Chicago. Secy., E. H. Fritch, 900 So. Michigan Ave., Chicago.

NATIONAL RAILWAY APPLIANCES ASSOCIATION.
Mar. 21-23. Annual meeting in Chicago. Secy., B. V. Crandall, 1824 Lytton Building, Chicago.

ILLINOIS GAS ASSOCIATION.
Mar. 22-23. Annual meeting in Chicago. Secy., H. H. Clark, 136 So. Harvey Ave., Oak Park, Ill.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Apr. 11-14. Spring meeting in New Orleans. Secy., Calvin Rice, 29 W. 39th St., New York City.

AIR BRAKE ASSOCIATION.
May 2-5. Convention in Atlanta. Secy., E. M. Nellis, 53 State St., Boston.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 15-18. Annual meeting in Chicago. Secy., J. G. Crawford, 547 W. Jackson Blvd.

MASTER BOILER MAKERS' ASSOCIATION.
May 23-26. Convention in Cleveland. Secy., H. D. Vought, 95 Liberty St., New York City.

Institute for City Engineers and other public works officials is meeting this week (Mar. 14 to 18) at the University of Kansas, at Lawrence. Of the 20 addresses announced in the program 17 are by professors.

Engineers Society of Western Pennsylvania has elected the following officers for 1916: President, Samuel Lee Duff; vice-president, W. E. Snyder; directors for three years, Wm. E. Mott, Henry D. James. Robert Linton and George Danforth have since been appointed directors to fill vacancies caused by resignation.

Canadian Good Roads Congress—The third Canadian International Good Roads Congress was held at Montreal, Mar. 6 to 10, with an attendance of about 1,000. The sessions were presided over by D. Michaud, Deputy Minister of Roads for Quebec. A number of papers were read at the various sessions by engineers from Canada and the United States, dealing with various features of road construction, and there was an extensive exhibit of road materials and appliances. The new officers elected are: President, J. Duchartel de Montrouge, Outremont; vice-president, F. L. Squire, Toronto; secretary-treasurer, George A. McNamee, Montreal. The meeting a year hence will be held in Winnipeg.

New England Water-Works Association held its regular monthly meeting on Mar. 8 at the Hotel Brunswick, Boston. After the usual luncheon the discussion of the final report of the Committee on Meter Rates, which was not completed at the February meeting, was resumed. A large number of members of the association took part in the discussion, and the report was finally referred back to the committee, with the request that it submit to the association the other method of charging for water which it had under consideration when it recommended the one given in the report. While many members approved of the recommendation of the committee, there seemed to be a general feeling that the matter was one of such importance that the association as a whole should consider it thoroughly before adopting the committee's recommendations. Robert Spurr Weston read a paper on the proposed auxiliary water-supply of the City of Brockton.

Appliances and Materials

New Expansion-Joint Material

A new material for expansion joints in concrete, brick or stone-block paving or in masonry work has recently been marketed by the Barrett Co., New York City, manufacturer of bituminous materials. The new material is a mastic in ribbon form, but without felt or paper reinforcement. It is claimed that a joint made with this ribbon will have all the properties of a poured joint and can be constructed easier, quicker and cheaper. Shipment is made in rolls; various widths and thicknesses are available. The trade name will be "Barrett's Expansion Joint."

* * *

Radical Departure in Electric Wiring

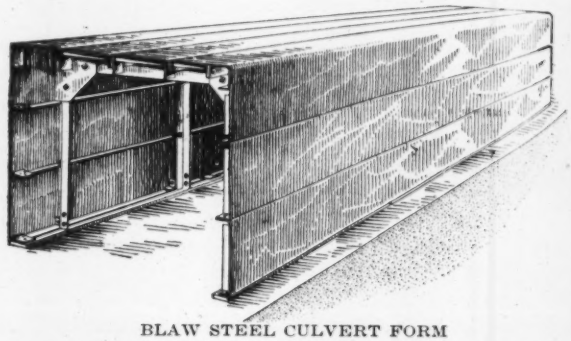
A radical departure (for this country) in house-wiring equipment has been brought out by the General Electric Co., Schenectady, N. Y., in the shape of the so-called "concentric" conductors and fittings. The system has been used abroad to a considerable extent in existing buildings where electric service was desirable, but the ordinary wiring schemes too expensive. The running conductor is 0.22 in. in diameter and consists of a No. 14 solid wire, rubber insulated and single braided; it is jacketed with a closed tinned water- and gas-tight copper sheath (folded longitudinally around the insulated wire and soldered along the lap. The current capacity of the sheath is equal to a No. 12 wire. It serves as the return conductor, is made electrically continuous throughout each installation and is grounded. The wire is supported by small metal clamps.

The fittings are similar in general appearance to the present equipment, but the connections are designed for easy and quick placing. Neat installations are possible without disturbing the walls. There has been a demand for this equipment for small-customer premises; special permission of insurance underwriters has to be obtained for its use.

* * *

Steel Adjustable Culvert Forms

An adjustable steel rectangular culvert form has been devised by the Blaw Steel Construction Co., Pittsburgh. The construction is shown in the accompanying sketch. The form is composed of plates 12 in. high and has 12x12-in. bracketed corners with brace angles in the interior, which support the sides and roof. A small number of hook bolts are used to connect the roof panels and the side panels to the supporting interior angles through the outstanding flanges of the panels themselves. They draw the entire form together, are very



BLAW STEEL CULVERT FORM

easily inserted in place and are a permanent part of the interior supporting angles. The adjustment is made by either adding or removing a 12-in. side or roof panel. The sections are united by a slip joint quickly operated by hand.

They are in 5- and 10-ft. lengths, and sets are furnished for five lengths, of 25 to 40 ft.; each set is adjustable for culverts from 2x3 ft. to 5x6 ft. Prices run from $220 to $440.

* * *

Efficient Rotary Pump

An interesting gear-type rotary pump has been designed and is being made by the Viking Pump Co., of Cedar Falls, Iowa, the principle of which is shown in the accompanying sketch. There are only three parts—an annular gear, a spur gear and the casing. The annular gear is larger than the spur gear, so that the latter meshes with it by being placed off center; as the spur gear is driven, the annular gear revolves about its own center. A crescent-shaped diaphragm, part of the casing, fills the gap between gear circles caused by offset centers. As the gears revolve, the inter-tooth pockets of the spur gear are filled with water, which is moved past the crescent diaphragm and crowded into the outlet space.

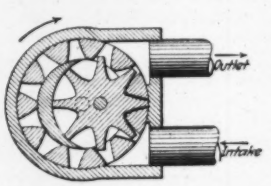


DIAGRAM OF "VIKING" ROTARY PUMP

This pump is made in various small sizes. Tests on a 2-in. pump (suction and outlet) showed efficiencies of 49 to 76% for 45 to 94 gal. per min. under heads of 118 to 100 ft. and at speeds of 215 to 400 r.p.m. A suction vacuum as high as 25 in. of mercury was secured.

* * *

Footwarmer for Watchmen and Policemen

A warming plate, on which watchmen and policemen on fixed-post duty may comfortably stand in cold weather, has been developed by Drew Johnston, of the Duquesne Light Co., Pittsburgh, at the instigation of Councilman Robert Garland and with the coöperation of the Westinghouse Electric and Manufacturing Co. The plate is 18 in. square and contains an 80-watt electric heating element; 10 ft. of armored cable leads to a plug and receptacle, the latter being placed in a special pole box. The name "Tootsietherm" has been applied to the device.

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MAR 24 1916
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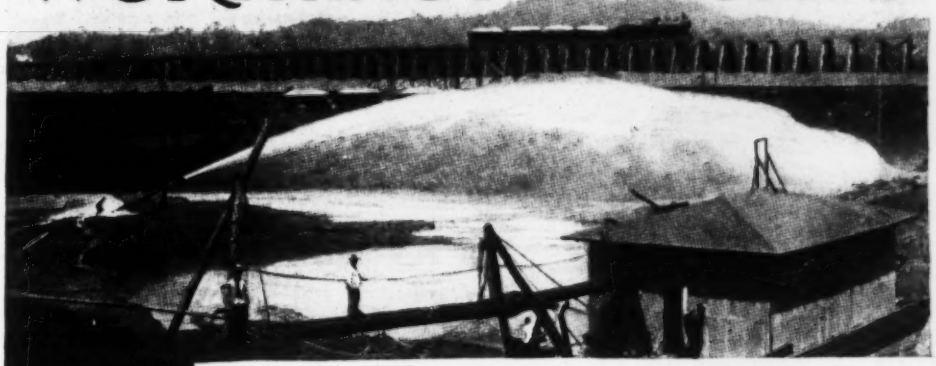
What Bennett's History of the Panama Canal says about WORTHINGTON PUMPS



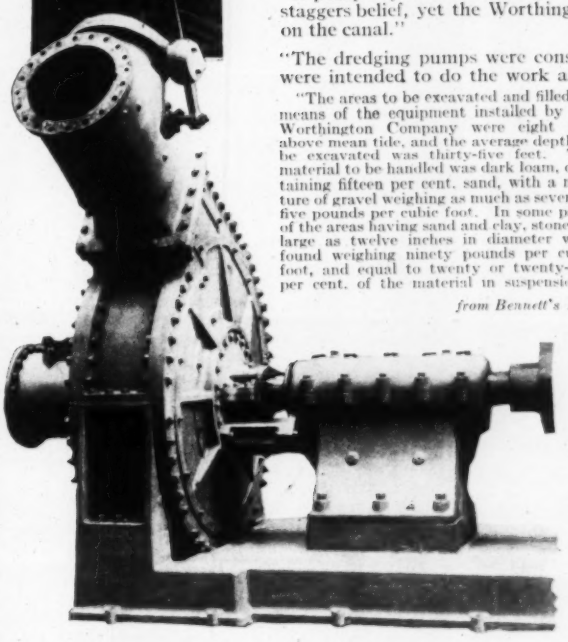
"A pump capable of handling 300 cubic yards of solid matter per hour almost staggers belief, yet the Worthington Company had four such pumps at work on the canal."

"The dredging pumps were considered the most powerful of their kind, and were intended to do the work assigned them in one lift of ninety-five feet."

"The areas to be excavated and filled by means of the equipment installed by the Worthington Company were eight feet above mean tide, and the average depth to be excavated was thirty-five feet. The material to be handled was dark loam, containing fifteen per cent. sand, with a mixture of gravel weighing as much as seventy-five pounds per cubic foot. In some parts of the areas having sand and clay, stones as large as twelve inches in diameter were found weighing ninety pounds per cubic foot, and equal to twenty or twenty-five per cent. of the material in suspension."

"The method of operation was to sink the dredging pumps by stages in the prism to be excavated, until rock was reached, the sedimentary material being mined with the monitors, and sluiced by the dredging pumps. For mining and sluicing, salt water was used through all the pumps. The available power was 3,000 electrical horsepower. The plant was designed on this basis for operating the dredging pump motors. The pumping plant had a capacity of 20,000 gallons per minute, pumping the same through 3,600 feet of main pipe, and 500 feet of branch lines."

from Bennett's History of the Panama Canal.



This high record achievement at Panama is being duplicated by Worthington Pumps in many great projects of Hydraulicing, Irrigation, Mining, Dredging, Waterworks and Sewage Disposal. A Worthington Pump may solve your pumping problem with equal success.

Bulletin W600-19 will be sent on application.

HENRY R. WORTHINGTON
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Buffalo	Detroit	Louisville	Salt Lake City
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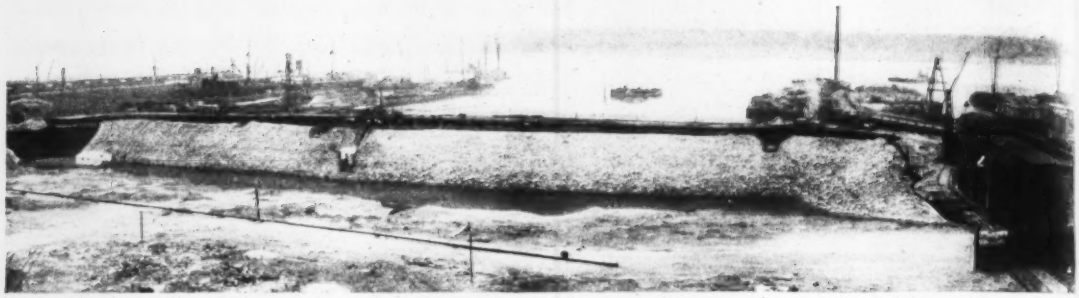
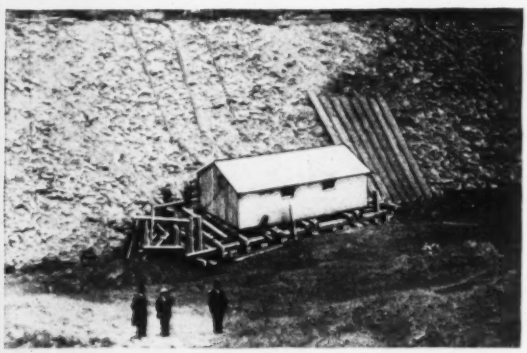


Unwatering the Lackawanna Sheet Piling Cofferdam for the 46th St. Piers, New York City

This work required the removal of about 55,000,000 gallons of water from an area of 300 by 800 feet and inasmuch as the maximum head on the unwatered dam was estimated to be 51 feet, no effort was made to reduce the water level quickly, it being considered advisable to let the dam take a set at intervals.



A 10-in. centrifugal steam pump, capacity 250 g.p.m. was able to reduce the head 6 or 7 inches per 16-hour day. This pump (first small picture) was mounted on skids near the middle of the river side of the cofferdam. These skids and the pump were slid down the steep slope as the pumping proceeded, to keep the pump suction close to the water level. The lowering was done with tackles attached to the Lackawanna Sheet Piling sections in the cofferdam.

An auxiliary pumping plant (lower small picture) consisting of one 4-inch and two 6-inch electrically-driven pumps, mounted on a timber float was also brought into service and operated 8 hours per day.

Unwatering proceeded without special incident until when 13 feet below mean low tide (17½-foot head at high tide) leakage developed from underneath the single row of sheet piles on the 47th Street side of the cofferdam. This leakage was stopped by a novel method.

A 12-inch round timber pile was driven in the old fill back of the crib and pulled. The opening was then filled with layers of earth and sawdust and manure. Plugs of this material were driven down until each whole plug had been driven into the sub-surface and the pile was in its old position. The pile was then drawn and the process repeated from three to twelve times in holes at intervals of two feet.

The leak lasted a week and was of such extent that the 10-in. pump was able to keep a level; that is, from 6 to 7 in. per day apparently leaked into the dam. At last the leak was plugged and pumping continued until when at a level of 15 ft. another leak of the same sort developed. The plugging work as described was continued until no leakage was apparent and the level was down to 21.

Six weeks of pumping brought the level down to 35 feet below mean low tide, at which point rock excavation and construction of a permanent sump were commenced. From that point, the 10-inch pump running days' with one of the 6-in. pumps running nights, kept the leakage down. More recently the leakage has been confined to springs that have been uncovered, and has been easily removed by the 4-inch pump alone.

Inasmuch as the 46th Street Cofferdam is the largest and deepest structure of its kind ever unwatered, the performance here is convincing evidence of the watertightness of the Lackawanna type of interlock and its superiority in subaqueous construction work.

LACKAWANNA STEEL COMPANY

General Sales Office and Works: Lackawanna, N. Y.

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Licensees for the manufacture of Lackawanna Steel Sheet Piling:

For Great Britain and British Colonies in the Eastern Hemisphere, Cargo-Fleet-Iron Co., Ltd., Middlesborough, England. For France, Italy, Spain, French Colonies and Protectorates, Italian Colonies and Spanish Colonies in the Eastern Hemisphere: Cie Des Forges & Aciéries de la Marine et d'Homécourt, Paris, France.

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Susquehanna Concrete Viaduct Built in Halves

SYNOPSIS—Single-track steel-truss bridge is being rebuilt as two-track concrete-arch viaduct. One longitudinal half was built last season and the old bridge taken down. Contractor's plant fully described. Pneumatic concreting tried, but abandoned in favor of bucket cars. Arch centers described.

Unusual methods are being used successfully in building a 4,000-ft. concrete-arch bridge over the Susquehanna River at Harrisburg, Penn., on a very fast schedule of completion. Until December, 1915, the Cumberland Valley R.R. crossed on a single-track deck truss bridge of twenty-two 170-ft. spans. In its place a double-track concrete-arch bridge of 45 spans averaging 76 ft. is being built on the old piers, with the addition of one intermediate pier in each of the old spans. Traffic must be maintained, and the bridge is therefore built in longitudinal halves. The south half was completed in 1915; the north half will be built in 1916, the steel-truss bridge being now removed. Virtually, two entire 4,000-ft. bridges must be built, each in a single season.

The working scheme of the contractor, the Robert Grace Contracting Co., Pittsburgh, has the following characteristic features: (1) Avoidance of all river falsework under the concrete; (2) handling steel centers in integral spans, without dismounting and reërecting; (3) two concrete-handling methods—bucket cars and air blowing; (4) sheet-steel lagging for the arch intrados and no extrados lagging whatever; (5) tying into the old pier masonry to hold the forms for the incasing concrete; (7) use of steel stringers for the working trestle.

The foundations were built to about low-water level in the fall of 1914, by railroad-company forces; this work included enlarging the footings of the old piers. In the winter the steel-truss bridge was moved 8½ ft. north on the old piers. They were wide enough, having originally been built for double-track superstructure, but fitted with a single-track bridge placed centrally on the masonry. The Pennsylvania Steel Co. did this work successfully, under traffic. At the beginning of the 1915 season, therefore, the bridge was in shape for prompt work on the superstructure. Work began in March.

A controlling feature of the work is the presence of an island about 300 ft. wide in the middle of the river, dividing it into two channels each about 1,600 ft. wide. This island made it possible to place the main mixing plant and shops in a central location. A trestle siding leading off the bridge track was built, to enable material trains to be brought in over the bridge itself.

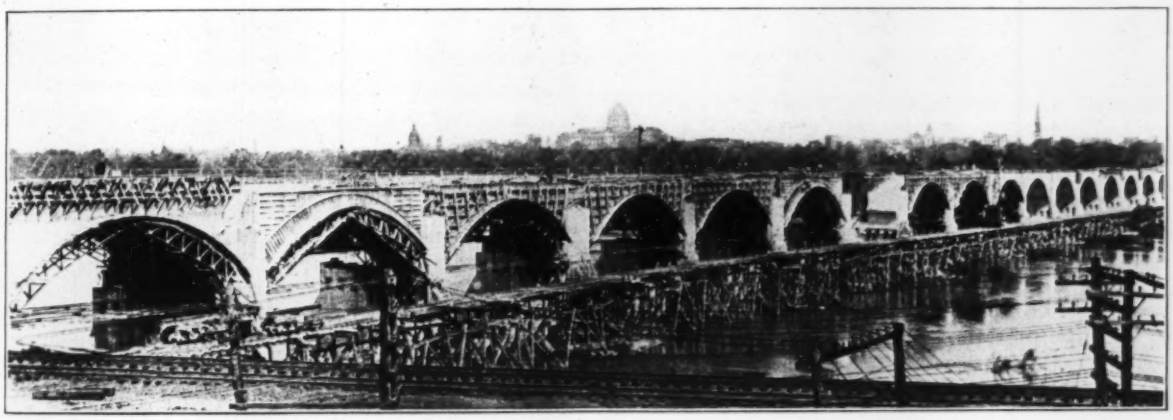
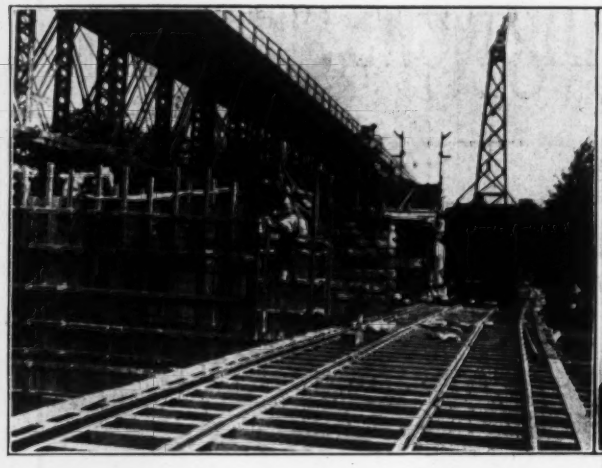


FIG. 1. SUSQUEHANNA VIADUCT AT ALL STAGES OF RECONSTRUCTION

The contractor's plan of procedure for the 1915 work was to carry on all work from a trestle built close alongside the viaduct at an elevation a few feet below the springing line of the arches. Such a trestle would be necessary in any event. By using it, not only to transport the centers, but also to handle all material, including the concrete, great simplification was secured.

All hoisting was done by a pair of 7½-ton McMyler-Interstate locomotive cranes of 37-ft. height of reach, running on the trestle. Centers were transported bodily, one complete span at a time, on cars running on the crane track. Concrete was handled from the mixing plant on the island by Doud Special bottom-gate buckets seated two on a car in two-car trains hauled by gasoline mine locomotives on narrow-gage tracks on the same trestle.



FIGS. 2 AND 3. LEFT—FLOOR OF WORKING TRESTLE; RIGHT—DERRICK ON HALF OF STEEL BRIDGE UNLOADING MATERIAL ONTO TRESTLE

The plan of attack was to begin at the west, or Lemoyne, end of the bridge and work toward the island, having built the trestle across the west channel of the river; then, as the most westerly arches were completed, to move the westerly sections of trestle to the east channel and erect outward from the island, ultimately reaching the east, or Harrisburg, bank by the time the west-channel arches were completed. This scheme gave at all times two or three working points, distributed over both channels, which could be served by tracks leading out in both directions from the mixing plant; and at the same time there was only as much trestle as was required to cover one-half the total length of the bridge.

This ingenious scheme was interfered with by an exceptional amount of high water during the summer, which made it slow work to get at the pier footings, and also by delays at the west bank of the river, in connection with a turnout of the Northern Central R.R. Two supplementary concreting plants were therefore provided to handle work near the west bank:

1. A portable ½-yd. Smith mixer furnished the concrete for placing two shore spans on the west end.[1] 2. A pneumatic conveying, or concrete-blowing, plant was set up at the west bank, to supply some of the river arches independently of the trestle, which could thus be shifted sooner.

The trestle construction was as follows: Six-post bents of four plumb posts and two batter posts, 23 ft. apart on centers; 12x12 caps; 2x6 sash timbers and bracing; four stringers, 15-in. I-beams, one under each rail. These I-beams were in 72-ft. lengths, alternating with 24-ft lengths, the long ones in each case facing an arch span, the short length being at the pier. The lengths lapped past each other without connection. The beams rested on the caps and were held down by rail spikes. Midway between bents they were braced by bridging consisting of plank diaphragms cut in between the beams and a pair of transverse clamping strips above and below the beams, tied together at the ends by bolts. The beams were not punched or fitted in any way, to realize maximum salvage.

The track arrangement on the trestle was such that four rails gave three running tracks, the crane running on the middle pair of rails (standard gage) and the concrete cars on the outer pairs. There being a double turnout from these narrow-gage tracks into the mixer siding, it was possible to keep three trains in service between the mixer and the place of concreting without having a crossover at the delivery end and therefore without constant relaying of track.

The main concreting plant on the island consisted of a pair of bins with a capacity of 250 cu.yd. stone and 125 cu.yd. sand, located under the turnout trestle from the bridge. This trestle held about four cars for successive unloading into the bins. Cement bags were chuted down a slide into a cement house alongside the mixer platform below the bins.

Under the bins the plant was double, with two sets of outlets and gates, each feeding into a four-hopper Hains mixer set to discharge directly into the bucket on the car. Each of the mixers was rated at about 350 cu.yd. per day. The best day's work was 400 cu.yd. for the two.

The plant was located in line with one of the arches of the viaduct, but clear of the structure, on the side opposite the trestle track; thus the track from the mixer led out into the trestle track both east and west.

The individual working section (one span of arch, half the width of the bridge, or a pier lift of ordinary height) averaged between 200 and 225 cu.yd. The plant could supply three or four working sections simultaneously.

Experience with Concrete-Blowing Plant

The concrete-blowing plant comprised bins under the bridge track (filled by dumping cars through the bridge floor), a cement-storage house (cars unloaded by hand to a chute), a McMichael receiver of ¼-yd. capacity, fitted with gates and air valves for admitting air above the charge and in the ejector nozzle below, and 800 ft. of 8-in. blowing pipe. It was possible to lay the latter on the old steel bridge at the edge of the footwalk without interfering with the railway clearance.

The blowing receiver was supplied with air by a 5-in. main laid on the deck of the railway bridge, from a compressor house on the island. This house had two compressors working at 110 lb. per sq.in., with a combined capacity of 1,300 cu.ft. of free air per minute. They fed into three horizontal tanks totaling about 750 cu.ft. capacity, from which the 5-in. main led out. A safety

[1] This work was in other respects also outside the regular working system, inasmuch as wooden centers were used; the work was handled as a job independent of the main portion of the bridge.

valve on the tanks and an unloading bypass on the larger of the two compressors controlled the pressure. Steam was supplied by two 100-hp. boilers, consuming 2½ to 4 tons of coal per day.

Originally ¾-in. stone was used with the blowing plant; but this proved to be not well suited to the work, and 2½-in. stone was later used successfully. Water was fed into the blowing tank by a Lakewood automatic tank (with graduated gage), and the mixture was made with a 5-, 6-, or 8-in. charge of water per batch, just as called for by the foreman in charge of concreting.

At the discharge end the elbow of the 8-in. conveying pipe discharged into a hopper, from which a spout or pipe distributed the concrete over the form; direct discharge into the forms would have been too violent. The elbows in the piping were made of four 22½° bends, giving a quarter circle of 4-ft. radius. This has been found more satisfactory by the contractor than the use of single-length 4-ft. elbows.

The blowing plant saved the labor of two men and the repair and fixed charges of two bucket-car trains; on the other hand, the running cost of the compressor station must be charged against it. Under these conditions the cost of mixing and placing has been distinctly higher for the pneumatic plant than for the main plant, according to the contractor's people. After concreting at the west end, the pneumatic system was moved to the island and placed under the end of the bins. From this location it placed concrete in the bridge east of the island. At neither point was the chuting distance greater than 800 ft.

It is stated that the air plant did not place concrete as economically as was done by the main concreting plant, which was the reason for not attempting to chute beyond 800 ft. From Oct. 1 to Nov. 31 the contractor worked a day and a night shift, using the other mixing plant (with Hains mixers) exclusively. In September and October a total of 8,000 cu.yd. of concrete was placed per month. Concreting the south longitudinal half of the bridge (the first season's work) was finished on the evening of Nov. 31.

Steel Centers and Bracket Supports

The steel centers used for the arches are of the now common three-hinged type, with turnbuckle tie. The spans of the bridge alternate 74½ and 77 ft. in the clear. Instead of trying to adjust the centers to the 30-in. difference by changes in the steel the contractor makes the change to the larger arch by blocking up the circle strips that support the lagging; for the shorter arch the circle strip rests directly on the top flange of the center. There are four centering ribs for the half-width of the bridge, 16 ft.

In the absence of a coping or belt-course to support the arch centers it was necessary either to support them on bents set on the river bottom or to provide some attachment to the side of the pier. Temporary supports in the river being very undesirable, bracket supports were adopted. Pockets were cored in the pier sides to receive these brackets; they were plastered full after the removal of the centers. The sketch, Fig. 7, shows in approximate manner the brackets and the blocking on them to carry the arch centers. The four brackets were braced in pairs.

The centers were cambered 1½ in. above the designed curve of the arch. The turnbuckle tie was not used to hold the thrust of the centering arches under load, but the centers were wedged against the face of the arch stub or umbrella by blocking.

The arch lagging consisted of No. 24 black steel sheets carried by transverse planking separated by 1-in. spaces. In the first few arches concreted the planks were 4x6's, a size having little scrap value. Later the planking was changed to two layers of 2x8, with 1-in. spaces in each layer, the planks of the two layers being staggered or

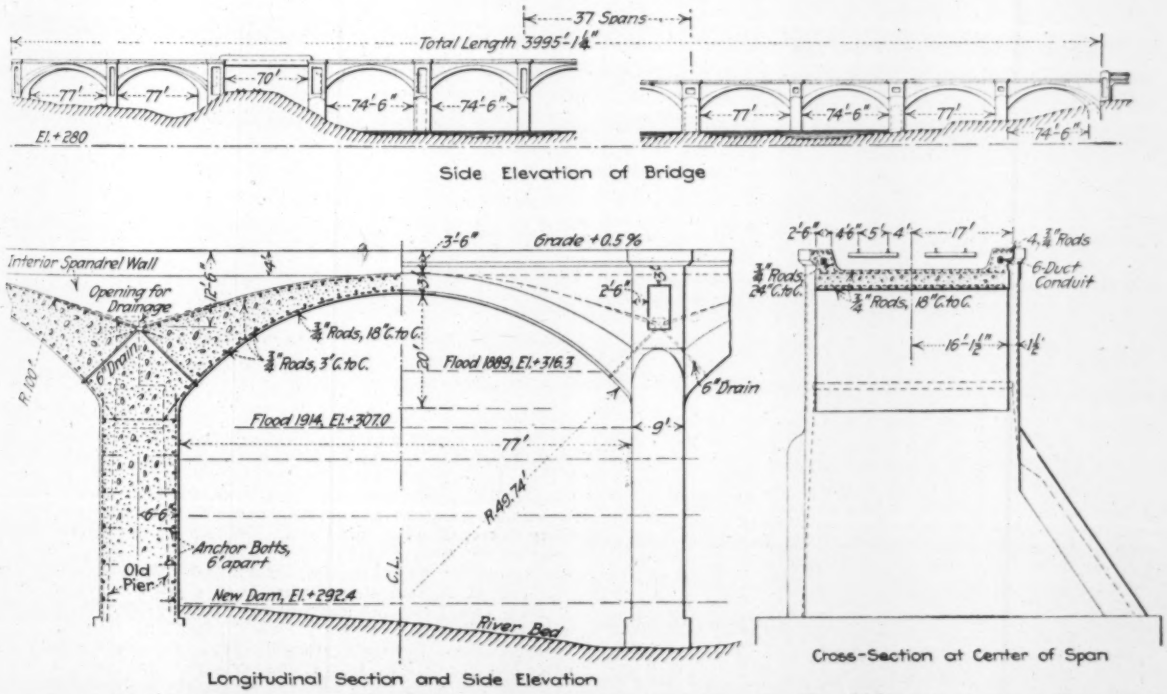


FIG. 4. GENERAL DESIGN AND DETAILS OF SUSQUEHANNA VIADUCT OF THE CUMBERLAND VALLEY R.R.

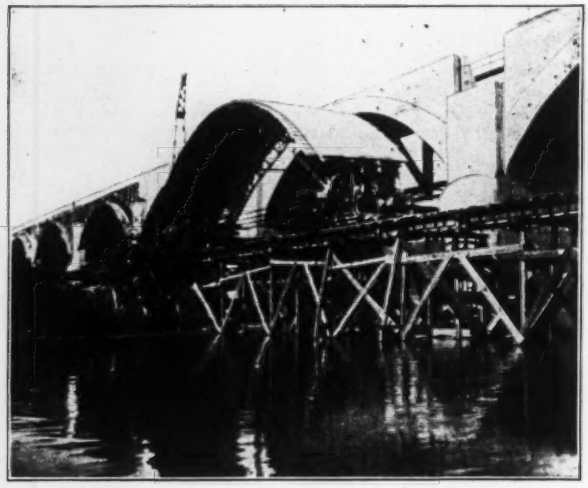


FIG. 5. ARCH CENTER ON TRUCKS BEING PUSHED TO NEW LOCATION

lapped. Spiking these down to the circle strip of the centers proved much simpler than with the 4-in. lagging. Every fourth or fifth strip was bolted through, the intermediate ones being merely tacked together by spikes.

The forms for the spandrel walls were of the sectional type, as were also the side forms of the arch ring and the side forms for the second or main portion of the arch ring (the ring showing on the face is only about two-thirds the inside ring thickness).

The pier forms were tied by ½-in. rods with Universal form clamps in place of nuts. A tin speaking-tube placed over each rod enabled it to be drawn out after stripping the forms. The forms for the enlargement of the old piers were tied to bolts grouted into holes drilled 45° below the horizontal about 18 in. into the old masonry.

The ellipsoidal tops of the pier nosings were formed with 6-in. strips of sheet steel, lapped at their edges, held by nailing to battens at top and bottom.

The arches were concreted without the use of top lagging. The slope of the extrados at the pier, where it is steepest, is about 1 on 3. To make this slope stand in wet concrete required placing a very stiff mixture in the outer portion of the arch. This was spaded to the face. In the first two or three arches concreted, top lagging was used; but after a trial was made of spading the top face with a dry mixture, this method was adopted for regular use, with the approval of the railway company's engineers.

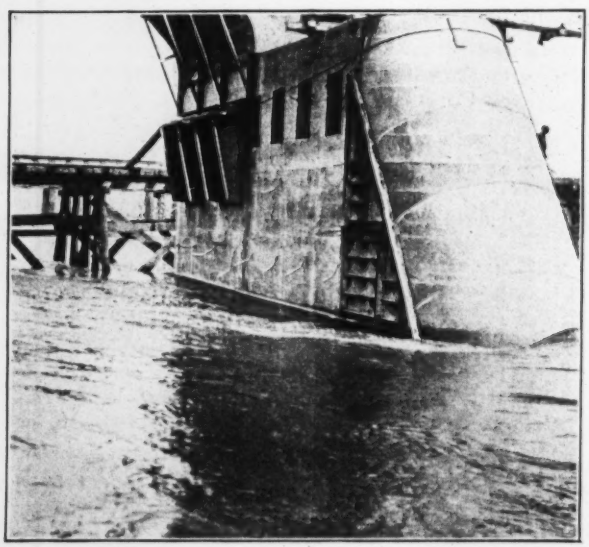


FIG. 6. HIGH WATER AT ONE OF THE PIERS

Arch centers were required to be left in for 30 days, which made it necessary to have six sets of centers on hand. Spandrel-wall work could be done in this period, however. The coping of the outer spandrel wall had to be cast separate from the wall itself, as a six-duct cable conduit was embedded in it. The middle or open side of the bridge, where the west half will join on next season, is closed off by a low spandrel wall, to retain the stone fill and ballast of the roadbed. This wall has no coping.

All surfaces of the concrete were left as they came from the forms. Offsets and honeycombed spots, of course, were made good, but other than this the surface was not touched. The bridge is not accessible for close view, except on the island.

At the close of the 1915 season, during which the south longitudinal half of the bridge was concreted, all trestle material and pier forms were stored for the winter on the island. The 11 centers, on their brackets, were left in place under the 11 arches last concreted. They will be moved upstream in the spring, when concreting recommences. The contractor decided to risk having the centers and the materials on the island washed out rather than incur the expense of removing them to a safer location on the mainland.

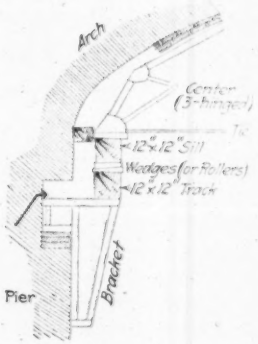


FIG. 7. BRACKET SUPPORT FOR ARCH CENTER

Railroad company forces have filled the arches with rough broken stone. A standard ballasted track was laid on top of the stone (rails are P. R.R. Standard, P. S. section, 125 lb. per yd.). On Friday, Feb. 4, 1916, traffic was put on the concrete bridge, and the steel structure was abandoned. Construction of the north half will begin about Apr. 1, or after the usual spring high water.

The Robert Grace Contracting Co., Pittsburgh, is represented on the job by B. R. Hundley, Supervising Engineer; J. J. Emes is Superintendent in charge of the work. For the Cumberland Valley R.R., Crosby Tappan, Engineer of Construction, is in charge, under the general direction of T. H. Kennedy, Engineer.

The Structural Engineers' License Law in Illinois was discussed by W. C. Armstrong, Chief Engineer, St. Paul Union Depot Co., in a paper entitled "The Relation of the Architect to the Engineer," read before the St. Paul Society of Civil Engineers and the Minnesota Surveyors and Engineers Society, Feb. 12. The architects' license law in Illinois was enacted in 1897; and up to Jan. 31, 1915, there had been granted under it 1,124 licenses, of which 917 were then in force. The Illinois structural engineers' license law took effect July 5, 1915, and 1,169 applications have been made for licenses under it, of which 613 have been granted and 556 are under investigation. It seems probable, says Mr. Armstrong, that after one year's operation of the structural engineers' license law there will be more licensed structural engineers in Illinois than there are licensed architects, although the architects' license law has been in operation 18 years.

Cost of Utility Changes Made To Avoid Interferences

By H. H. Shearer*

Gas, water, traction and electric companies stand in the position of joint tenants with regard to municipalities in their use of the public streets for locating their main-line plants. Each company's relation to the municipality is defined by franchise and ordinance, but there is seldom any clearly defined basis, other than the desire to be fair, to control the cases of plant interference between these companies. The determination of the correct method of estimating the just cost to be charged by an owner when he rearranges his plant to accommodate another company is the subject of this discussion.

It will be assumed that a company building a new plant or a new extension of its existing plant recognizes its responsibility not to jeopardize the existing plant of others and not to put others to any expense as the result of their additional occupation of the street. In short, the existing plants, by virtue of priority, have the right to remain undisturbed; and if they are disturbed, the newcomer must bear the burden incurred because of his work.

Conditions of Change

Different conditions governing the work necessary where the existing plant of one company must be changed or rearranged to accommodate the newcomer may be classified as follows:

A. The existing plant may be shifted without involving the replacement of plant units.

B. Plant units are replaced with units of (a) the same capacity, (b) different capacity.

Units are of the same capacity when they are equally serviceable, have the same potential use and the same life. For example: Two lead-covered cables having the same number and gage of copper wires similarly insulated are of the same capacity even if they differ in their physical type, but any variation in any of the essentials which varies the potential use of the cable creates a difference in capacity. Difference in type must not be confused with difference in capacity, for if there is no change in capacity, the difference in type is of no moment. This will be appreciated when it is remembered that there is no difference in value between two units of the same capacity, but of different types, because each has the same service capacity as the other, hence the same merchandise value. The market value of the now used type determines the value of both types, and the older type appreciates or depreciates from its original cost (and original value) to the value of the now used type. This greatly simplifies the valuation of units of different first cost, but of the same capacity as current prices always measure the value of the unit.

Considering then the conditions under which work is done, as previously mentioned, if we determine the theoretically proper practice to be followed in each case, we can arrive at a working practice to fit each condition. Following the classifications above outlined:

A. Here there is no question of any benefit accruing to the owner; and the other company must bear the entire cost of the change, which is being made for its accommodation. The gross cost will include all miscellaneous material, labor and incidentals, together with the owner's overhead or supervisory charges on such labor as is furnished by him. The net charges will be the gross cost less the value of any of the miscellaneous material recovered by the owner.

B. (a) The necessity for replacing one unit with another of the same capacity may be because of the inability to do the job in any other way or because it is more economical than to change the existing unit. Both conditions permit the same analysis.

The question of a betterment to the owner because of replacement of a partly worn-out unit by a new unit is introduced, and in practice there is always the further question whether this theoretical betterment will ever be realized by the owner. If the betterment is not realized, then it is of no value to the owner.

There can be no question that the miscellaneous material, labor, incidentals and overhead are charges to the second company, and the recovered miscellaneous material is credited as in A.

Regarding the replaced unit, it is theoretically correct to charge the net cost of the new unit to the second company (the net cost is obtained by subtracting from the present cost the present worth of the future recovery value of the unit when it is retired from plant), the recovered old unit being kept by the owner without crediting the recovery value, if any, against the cost of the job. In other words, the second company pays the net cost to the owner of the new unit and delivers the owner's original property, the old unit, to him.

In practice it is difficult to determine the present worth of the future recovery value of the new unit, because both the time when the new unit will be removed and its recovery value at that time must be assumed. The owner must use his best judgment, based on his practical experience, to determine this value.

Instead of trying to determine this figure, the recovery value of the old unit is frequently credited to the second company and the full cost of the new unit charged them. This is a simple adjustment and generally a liberal one, as the recovery value is credited at full value instead of on a present-worth basis.

It must be clearly remembered that this is a practical modification and not a fundamentally correct practice. It would lead to errors if applied to the next class of conditions.

(b) A change in capacity of units replaced may be for one of the following reasons:

1. A larger unit is used, because the owner desires to provide additional capacity in connection with the work. The owner should bear the entire extra cost of the work due to the change in capacity, as the increase is for his benefit; and the job should be charged to the second company, as if similar-capacity units had been used, and the credits adjusted on this basis.

2. A smaller unit is used, because the owner no longer needs to retain the full capacity of his plant. It is very evident that the fundamental principle, as given in B (a), must be applied and that the approximation of crediting the plant recovered to the job and charging out the new unit at full price is not correct. In extreme cases the value of the recovered units might even exceed the entire cost of the work, putting the owner in the position of paying the other company for a rearrangement of the owner's plant made for the benefit of the second company. The recovered units must go to the owner, and the estimated net cost of the new unit must be charged to the second company.

3. One large unit is used instead of restoring two or more smaller units, as an economy for the benefit of the second company. This again emphasizes the necessity of applying the fundamental principle in B (a) and avoiding the error of crediting the value of the recovered units against the cost of the job.

4. An obsolete-type unit is replaced with an approved type of as nearly the same capacity as can be obtained. Here there is no betterment to the owner, unless the obsolete type is defective, in which case the owner should replace it at his own expense. When the obsolete type is not defective, the case should be handled as in B (a).

It is seen that the one consistent principle that can be followed in all cases regarding the replacement of units is that of B (a), namely: Charge the job with the net cost of the new units not to exceed the capacity of the existing units, and make no credits for recovery value of units removed. Because of the ease of confusion in handling the material credits, careful attention must be given each case.

By basing each particular case upon the fundamentals herein given we believe a much clearer understanding may be reached by all who have to handle such matters.

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Small-City Pavings in Kansas

EDITORIAL CORRESPONDENCE

While there are no paved state or county roads in Kansas as yet, there is probably no other state in which the cities and local communities have made so much progress in paving—and it must be borne in mind that a city in Kansas often means a population of only a few thousand. There is in Kansas no city of 100,000 population, and only four—Kansas City, Topeka, Wichita and Lawrence—with over 20,000 population.

From statistics compiled by correspondence with city engineers the Kansas City (Mo.) *Star* has found that but three towns of more than 3,000 population have no paved streets and that 50 towns have paved streets. Only 14 of the 50 towns have more than 10,000 population, yet 20 of the 50 have each more than 10 mi. of paved streets; and of the 50 towns 23 have less than 5,000 population and two have less than 1,000. Practically all this paving work has been accomplished in the last five years.

These 50 towns and cities have 736 mi. of pavement, not including about 50 mi. of macadam, mostly water-bound, but some oil treated. From numerous editorial interviews and investigation it is safe to say that between 60 and 70% of these pavements are of asphaltic concrete. A great deal of it has been built under the well-known Topeka specifications.

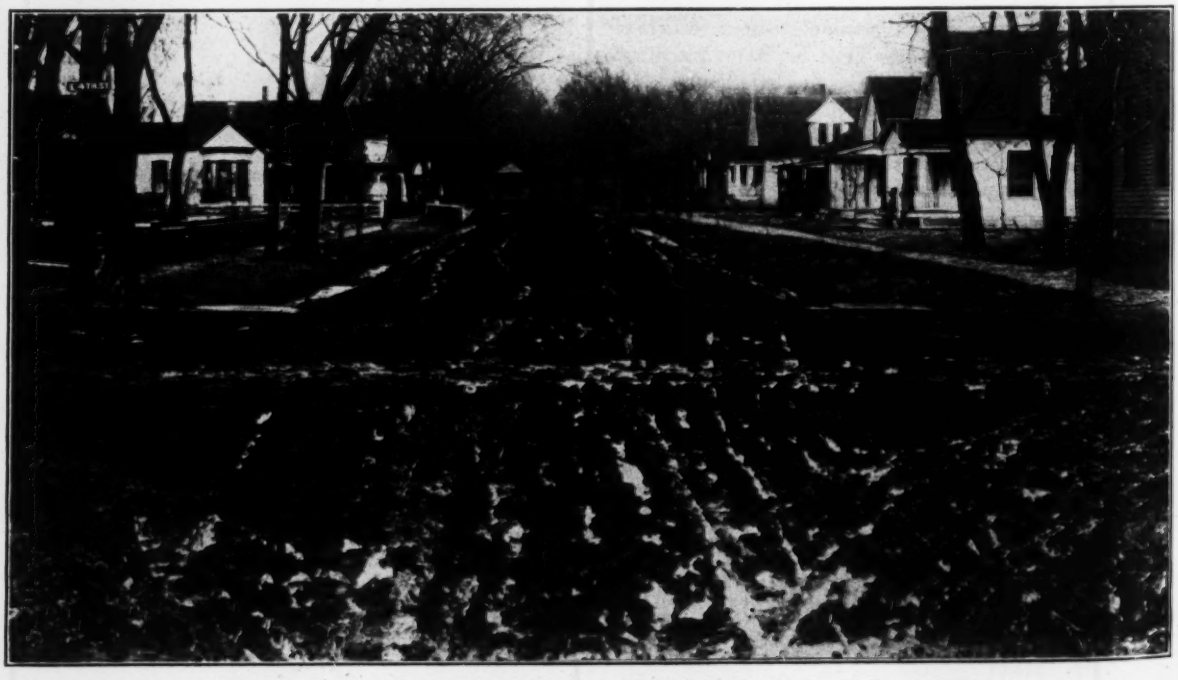
The original Topeka specification pavement was inspected by the writer on Jan. 21 and was found to be in almost perfect condition. But the excellence of this and other similar Topeka street pavements is not so much the result of the specifications as of the very strict supervision of the work and the constant tests and analyses of the mixture to see that it fulfills the specifications.

Most of the other pavements throughout the state are of brick on a 4-in. concrete base. The so-called vertical-fiber brick developed by the Western Paving Brick Manufacturers' Association is becoming popular. Concrete paving as yet has been used to a very limited extent in Kansas towns, although what is probably the smallest community in the country to have a municipally paved street has a half-mile of concrete pavement laid in 1915. This is Glasco, Cloud County, which has a population of only 860.

Many of these small communities make their municipal improvements on a large scale. For instance, Newton, a city of 7,620 population, laid 200,000 sq.yd. of asphaltic concrete last year in one contract, and the county and city engineer, F. E. Devlin, is about to let a contract for an equal amount this year. As county engineer he is also to build the first county-road pavement in Kansas, which will be 20,000 sq.yd. of asphaltic concrete. These pavements are laid under specifications similar to the Topeka specifications, except that Trinidad Lake asphalt is especially provided for. The paving in Newton last year cost $1.18 per sq.yd. for a 4-in. concrete base and a 2-in. wearing surface of asphaltic concrete. Pavements of this type in Newton have been down for 10 yr. without repairs of any kind.

In general, the present year bids fair to be the busiest one yet in the Kansas paving industry. Much of this work is done by local contractors, such as the Kaw Paving Co., Topeka, which enjoys the distinction of having laid the original Topeka specification pavement; but many of the large contracts are let to Chicago and other Eastern firms. In many of the smaller communities the county engineer also acts as city engineer of one or more of the principal towns, but a considerable part of the paving work is handled by consulting municipal engineers whose headquarters are in Kansas City, Mo.

All city paving work in Kansas is done by assessments on the abutting property, and a majority of abutting property owners may cause any street in any town to be paved with material of their own selection. A few object-lesson pavements in each locality are all that is



END OF LELAND ST., TOPEKA; A TYPICAL KANSAS UNIMPROVED STREET

FIG. 1. MILL-FLOOR CONSTRUCTION OF BRIDGE FLOOR

View shows the diagonal subplanking and the transverse floor planks, the latter set on edge. Between the track rails these planks are laid on the longitudinal spiking pieces

necessary to create a very strong public sentiment in favor of paved streets. The accompanying view shows a typical (Kansas) unpaved street in Topeka, as it looked Jan. 23 and as it looks after every rain and when the frost comes out of the ground. It is said that, when a street is paved, the effect in stimulating property owners to make their premises more tidy and presentable is quite remarkable. There is certainly little inducement to do so with a slough of black, sticky mud in front of the houses.

Light Wood Floor for Bridges

A specially light-weight wood floor for bridges where minimum weight is desired consists of transverse planks laid on edge and placed close together, as in mill-floor construction. This form of pavement is adapted particularly to bascule bridges, where saving in weight is important.

Such construction, as used on the bascule span of the Cherry St. bridge at Toledo, Ohio, is shown herewith. On the floor-beams are laid I-beam stringers to which are bolted wooden nailing strips, these varying in thickness to give the proper crown to the roadway. Across them are laid diagonal planks (at an angle of 45°), which are of 4x6-in. material planed to 3¾ in. thickness and spaced 6 in. apart.

Upon this subflooring are laid the floor planks, at right angles to the line of the bridge. They are of hard maple (or beech), sized to 1⅞x3¾ in. and set on edge. They are nailed together at the timber-treating plant in sections 5 ft. long and are toe-nailed to the diagonal planks. In the joints between the sections are placed two thicknesses of three-ply tarred roofing felt. In some cases the planks are 2⅞ in. thick and are not put together before delivery. The floor is mopped with pitch and sprinkled with sharp gravel (⅛- to ¼-in. size). This is ground into the wood by the traffic and gives a better wearing surface than ordinary plank flooring.

The nailing strips and subplanks are of yellow pine, and they, as well as the floor planks, are given a preservative treatment. For the street-railway tracks I-beams riveted between the stringers and trusses carry the rails and also longitudinal spiking pieces, upon which are laid the floor planks between the rails.

This timber flooring with the grain horizontal will not resist wear so well as wood blocks with vertical grain, but it is lighter than wood-block paving and is more durable than ordinary plank flooring. Its weight is

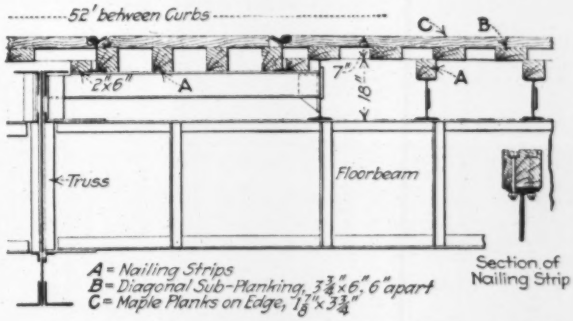


FIG. 2. MILL-FLOOR CONSTRUCTION OF FLOOR FOR BASCULE BRIDGE

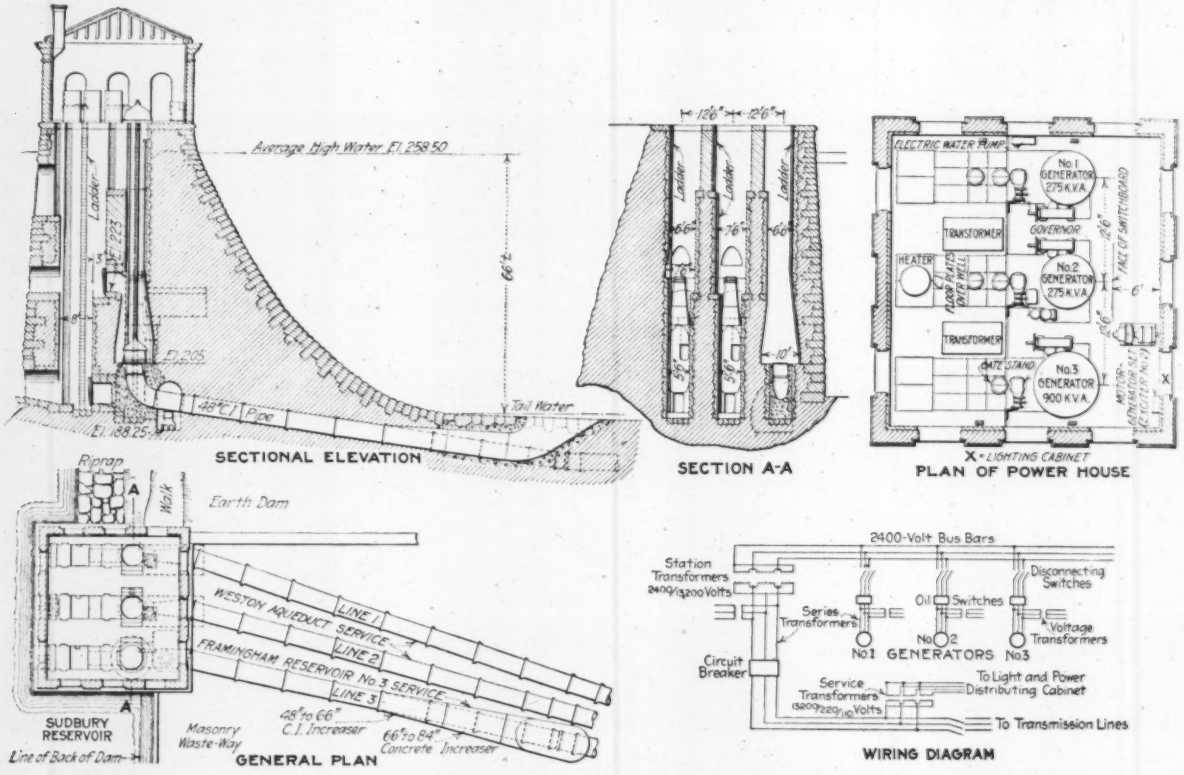
about 20 lb. per sq.ft., including the tar surfacing but exclusive of the subplanking. The mill-type floor construction was designed by the Jennison-Wright Co., of Toledo, Ohio, and all the wood is treated with that company's "kreolite" wood preservative.

Pollution of a Deep Well by surface water was discovered recently at Madison, Wis. The well is furnishing the city's water-supply, and its water has shown a higher bacterial count than that from the other wells. Investigation of the casing showed it to be in good condition. Removal of the flanged inner portion at the top, which carries the suction pipe, revealed a hole, with a small horizontal pipe leading through the concrete cap at the head of the well. The pipe was cut off at the outer side of the concrete and gave free admission to surface water. The original purpose of the pipe is not known, but it may have been a connection to the hydraulic bearing of a former vertical pump shaft. To inspect the well, a bag of flaxseed was lowered about 60 ft.; when it swelled so as to plug the pipe, the water above it was pumped out. The investigation was made by E. E. Parker, city engineer and superintendent of water-works

Power from City Water-Supply at Sudbury Dam

Following the completion and successful operation of the hydro-electric power plant at the Wachusett dam (see *Engineering News*, Feb. 11, 1912, p. 294; Aug. 14, 1913, p. 297; Jan. 28, 1915, p. 169), the Metropolitan Water and Sewerage Board is now installing the machinery of a similar plant to develop power at the Sudbury dam in Southboro, Mass.

Water from the Sudbury reservoir flows into the Weston aqueduct and to Framingham reservoir No. 3, net heads of 37 ft. and 63 ft. respectively being available. The stone gate house at the dam, situated at the northerly end of the spillway, has been arranged to serve as a power station, and in it will be located the turbines, generators, governors, transformers and other necessary equipment. It is expected that the storage of the reservoir will permit the plant to be operated 16 hr. per day, and it is estimated that 3,000,000 kw.-hr. per year will be developed. The rate may be somewhat variable, depending upon the requirements of the water-supply, and may even fall to zero, if it becomes necessary to shut down the power plant.



HYDRO-ELECTRIC STATION AT SUDBURY RESERVOIR DAM

Three complete hydro-electric units are being installed. The wheels are single-runner turbines, with wicket gates and spreading draft tubes, and each is direct connected to a vertical-shaft alternating-current generator. The turbine on the Framingham service will develop about 1,000 hp., and the two on the Weston aqueduct will develop about 300 hp. each. The contract for the wheels was awarded to the S. Morgan Smith Co., the price being $11,760. The guaranteed turbine efficiencies of 84.82% for the reservoir No. 3 service and 84.15% for the Weston aqueduct service were exceeded when the wheels were tested at the Holyoke flume.

The electric equipment includes, in addition to the three main generators, two auxiliary 125-volt shunt-wound interpole direct-current generators to be used as exciters, one 200-volt 3-phase 60-cycle motor and the necessary switchboard, instruments, lightning arresters, etc.

The main generators will deliver 3-phase 60-cycle electric energy at a normal voltage of 2,400. The two generators for the Weston aqueduct service will deliver continuously 275 kv.-a., and the one for the Framingham service will deliver 900 kv.-a., both at 80% power factor with a maximum heating rise of 60° C. The generator voltage of 2,400 will be stepped up to 13,200 volts by two 3-phase 750-kv.-a., oil-insulated self-cooled transformers, and the power will be delivered to the Edison Electric Illuminating Co., of Boston, which has contracted to take it at the rate of $6.25 per 1,000 kw.-hr.

Duplicate underground cables will extend from the power house to a small building about 800 ft. distant, so that the beauty of the dam will not be marred by poles and overhead wires. Lightning arresters will be installed in the small building, from which a single overhead transmission line will carry the power to the Edison lines.

The electric equipment is being furnished by the Westinghouse Electric and Manufacturing Co., at a contract price of $19,349. The plant was designed under the direction of the late Dexter Brackett, as Chief Engineer of the Metropolitan Water-Works, with Frederic P. Stearns as Consulting Engineer; the equipment is being installed under the direction of William E. Foss, Acting Chief Engineer of the Metropolitan Water-Works.

Drainage Canal Deterioration*

By William A. O'Brien†

The ideal prism for a drainage ditch or canal is that which will develop the minimum deterioration or shoaling. The caving of banks to some extent is inevitable, but can be reduced by a carefully constructed section having wide berms and sloping banks.

The U-shaped section is universal within the Mississippi Valley. While a slope of 1 on 1 is generally specified, the work is usually constructed with a U-shaped section having greater bottom widths. The theory is that the slope will break at its neutral point and melt down to its line of repose on a slope of 1 on 1. But this assumption is not representative of slope adjustment on U-shaped sections on low-velocity canals.

The adjustment of slope on the U-section is evidenced generally by a vertical crack some 5 to 6 ft. from the bank line and extending to the medium stage of the channel. This rectangular section slides on its base and finds repose in the channel. The back slope of the void thus formed slacks down to ¾ on 1 or 1½ on 1, filling the unoccupied area in the center of the original prism. The final channel is a wide, shallow, semicircular section. The spoil area is frequently carried into the prism, with corresponding loss. Investigations on this type of section in southeast Missouri indicate that a loss of 40 to 60% in capacity may be expected.

Many dredging contractors believe that floating dipper dredges cannot dig sloping banks where the bottom width is less than 10 to 12 ft. But that they can construct such work with side slopes of 1 on 1, remarkably true to line, has been demonstrated on the work of the Little River Drainage District. We have completed 300 mi. of canals, of which about 200 mi. has 4- to 8-ft. bottom. The deterioration studies being made by the district include the investigation of some 75 mi. of canals in which permanent regimen has been established. The results are of interest in comparison with canals of the U-shaped section.

Caving of Side Slopes Lessened by Flattening

The deterioration in canals with slopes of approximately 1 on 1 is apparently due to the tilting of the seepage plane and the shrinkage of the soil. Relatively small rectangular areas then slide upon themselves, causing the slopes to flatten to about 1½ on 1 and the toes to draw together until they have formed a union. The average loss in capacity is 90%. This suggests that canals having free velocities of from 2.7 to 3 ft. per sec. will maintain themselves. The average scour being 33 cu.yd. per station, and the velocities being lower than noted above, the average silting in the canal is 50 cu.yd. per station.

It is very evident therefore that the sloping bank will reduce the deterioration and that a slope of 1½ on 1 is more desirable than 1 on 1. With a floating dredge it is entirely feasible to construct a slope of 1½ on 1.

If we assume that the runoff provided for is adequate and the roughness factor in the canal is correct, we will have perfect drainage from the theoretical section. If the loss in capacity due to deterioration is 30%, the work is not efficient and will result in financial loss by reason of crop losses, interest and the added increment in the unit cost per yard on the clean-out work. For a channel 6x8 ft. the cost at 7c. per cubic yard is $1,540 per mile. The yardage necessary to be removed to correct the loss in capacity is 6,600 cu.yd. per mile, costing from $800 to $1,000. The net loss to the landowner from this phase alone will be the cost of the clean-out, less the added yardage necessary in the initial construction to allow for deterioration, which will amount to approximately $500 per mile.

Berms of 15 ft. on canals up to 14-ft. bottom may be obtained as easily and cheaply as 10-ft. berms, because in the normal operation of a dipper dredge the spoil should be deposited outside the spud platforms. A canal of 8-ft. bottom and average cutting would require a 1½-yd. machine with 45-ft. boom. This would have about 56-ft. spread of the spud platforms, while the distance between the toes of the slope with a 10-ft. berm specified is only 44 ft. The type of dredge also controls minimum bottom width and maximum curvature.

Obstruction of Drainage Canals

The greatest loss, however, is in the landowners' abuse of the canals by improper open and tile drains, fences across the canals, the appropriation of the canal by willows and other growth and obstruction by bridges.

An open drain only 12 to 18 in. deep will, in seeking its grade line, wash out the berm and form a bar, or shoal, opposite. A tile drain not properly protected by head walls or a galvanized pipe at its end, discharging on a water cushion, will develop the same conditions. The contraction so formed results in a reduction of the carrying capacity, which may extend upstream several miles. In some cases this loss amounts to 60%. An open drain at its outlet should be practically at the grade of the receiving channel, with a uniform approach of 75 ft. For tile drains, 12 ft. of galvanized pipe at the outlet is preferable.

Fences act as barriers to drift and result in shoals from the sunken drift and silt deposit. No practical design of water gate is operative where the velocities are from 2 to 3 ft. per sec., as in drainage channels.

Willows or other growth will very quickly appropriate a channel to a considerable degree, causing a loss in area and increasing the roughness factor, with corresponding loss in discharge. The plowing down and cultivation of waste banks and the cutting of growth on the sides of canals will correct this loss and restore waste land for cultivation. Bridges that tend to retard and collect drift are exceedingly detrimental. Perhaps the worst is the temporary log bridge with short stringers, to afford access to a timber job. Upon the completion of the job the bridge is abandoned, forming a perfect barrier for the collection of drift, with the inevitable shoaling and loss in capacity.

Many state legislatures, realizing the detrimental effect of such conditions, have passed laws making the obstruction of a drainage canal a penal offense. In most cases, however, the land owners do not enforce the statute.

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*Abstract of a paper read at the sixth annual convention of the National Drainage Congress, at Cairo, Ill., January, 1916.

†Chief Engineer, Little River Drainage District, Cape Girardeau, Mo.

Seven Tunnels aggregating 1,000 ft. in length have just been started by the Pacific Gas and Electric Co., near Clipper Gap, Calif. The tunnels are 8 ft. 8 in. in diameter and are for conveying water, for power and irrigation, from South Yuba River.

Design of Darien Radio Towers

By C. A. Carlson*

SYNOPSIS—Why self-supporting towers were selected. Wind load assumed at 30 lb. T-sections expose minimum area to wind and corrosion. Stresses. Bolted field connections. Heaviest loads ever carried on porcelain insulators. Derrick boom falls 500 ft. during erection. Acceptance tests of station assure success of the chain of proposed high-power radio stations.

The rapid development of systems of radio, or wireless, communication capable of transmitting messages over long distances caused the United States Navy Department to realize the military value of a system of high-powered stations capable of communicating with each other and with naval vessels in all parts of the globe. The first high-powered station was built at Arlington, Va., in 1912. Subsequently an appropriation was obtained for a number of stations to be located in the Panama Canal Zone, on the California Coast, in Hawaii, Samoa, Guam and in the Philippines. The station in the Canal Zone, known

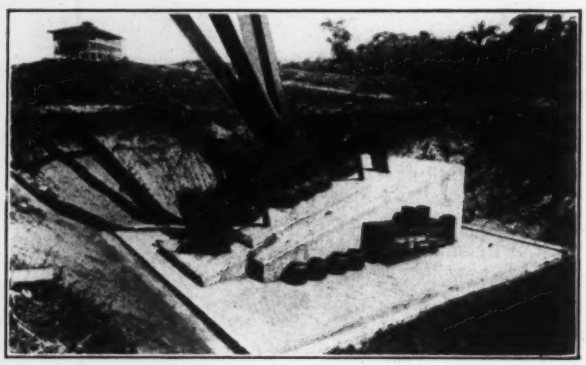

FIG. 1. HEAVIEST LOADS EVER CARRIED ON PORCELAIN INSULATORS

as the Darien station, was the first to be erected with these funds. It was completed sufficiently to permit of operation in May, 1915.

The site of the high-powered station on the Panama Canal was selected after a series of tests made to determine its suitability for radio work. In its topographical features the site was peculiarly difficult. It consists entirely of the steep hills or cones characteristic of land of volcanic origin. The site is bounded by the Panama Canal and by the relocated line of the Panama R.R. The station is about halfway across the isthmus, near a point on the railroad known as Caimito, and across from the point called San Pablo. Officially it is designated Darien Radio Station to distinguish it from the smaller secondary stations, one at Colon and one at Balboa.

Self-Supporting Towers Selected; Design

In determining upon the type of towers to be designed, consideration was first given to the use of built-up wooden masts stayed by guy cables, on account of their low first cost and the rapidity with which they could be erected

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It was soon realized that the decay of timber in a tropical climate would be rapid and that the corrosion of a large amount of wire cable would make the life of such structures very short, except at a high cost for repairs and frequent interruption to the service. Designs were then outlined by the Bureau of Yards and Docks of the Navy Department for a triangular steel mast of the open-lattice type, supported by guy cables throughout its length. Unless unusually high unit stresses were allowed in the guys, they became of considerable size, and with the introduction of so many cables the problem of maintaining them in adjustment and uniformly stressed under varying loadings became serious. It would have demanded of the operating personnel constant labor and attention in keeping the guys in adjustment and the masts in alignment.

From a military standpoint the towers or masts should be as rugged and simple to care for as possible. An alternative design therefore was prepared for a rigid, self-supporting tower. Both designs were for masts or towers 600 ft. high, to be placed in the form of a triangle in plan, the distance c. to c. of towers to be approximately 1,000 ft. A number of bids were received for both types of structures, including proposals for cylindrical tubular masts. The saving in first cost on the guyed masts, while material, was not deemed sufficient to warrant the sacrifice in permanency and safety afforded by the rigid, or self-supporting, type of tower.

The towers constructed are 600 ft. high with a spread of legs at the base of 150 ft. The legs, or base, of the tower extend to a height of 150 ft. A noticeable feature of these towers is the use of the so-called beetle-back system of sway-bracing. All the web members are of rigid section and are designed to take both tension and compression. The use of sway rods is limited to certain interior panels where they are used to stay members in compression.

The sole function of the towers is that of providing a support for an antenna, or aërial, of as large electrical capacity as possible, and with its center of gravity as high as possible. The antenna is composed of a mat of wires in the form of a gridwork of small silicon-bronze wires radiating in a fan shape, and inclosed within a

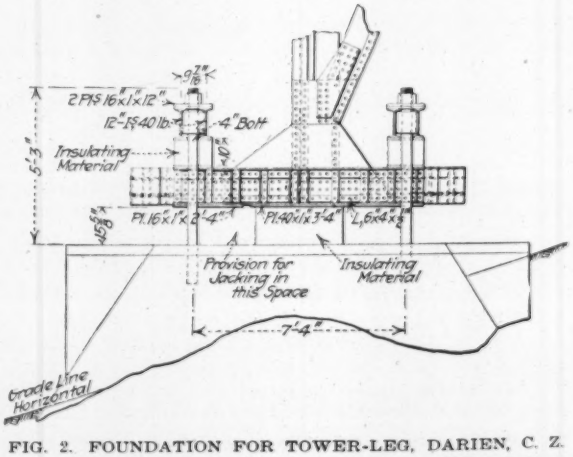


FIG. 2. FOUNDATION FOR TOWER-LEG, DARIEN, C. Z.

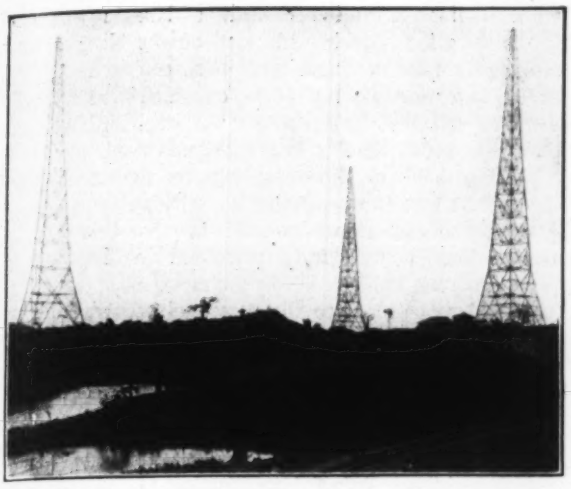


FIG. 3. GENERAL VIEW OF DARIEN RADIO STATION

triangle of supporting cables, forming a fan-shaped antenna. The catenary between each tower was limited to a deflection at the center of not less than one-tenth the span. The antenna forms a triangle with the sides of 920x880x750 ft. The wind load on the antenna and towers was assumed at 30 lb. per sq.ft. of surface normal to the direction of the wind.

Stress diagrams were made for the varying loadings, and the members were designed for the maximum stress that could occur under any possible combination of loadings. The occurrence of the maximum combination of stresses will be very infrequent and of short duration. The wind load is such a large proportion of the total load that for the combined stresses higher unit stresses than ordinarily used were allowed. Members were selected of proper section to meet the following requirements:

Allowable unit stress per sq.in. in compression

$$= 18{,}000 - \frac{70l}{r}$$

Tension lb. per sq.in. $= 18{,}000$

The $\frac{l}{r}$ was limited to 120 in the main columns and to 150 in the sway-bracing. Built-up members of T-sections were selected to obtain members with small exposure to wind, a minimum area exposed to corrosion, and with surface readily accessible for scaling and painting.

The stresses in some of the principal members are as follows: Main leg member C-58, 717,000 lb. compression; main leg member C-47, 658,000 lb. compression; inside leg member A-60, 12,350 lb. compression; diagonal member 47-46, 43,000 lb. tension or compression.

At the base the main columns are built up of a 15x¾-in. web plate, two 5x5x¾-in. angles, a 15-in. 80-lb. I-beam and an 11x¾-in. plate riveted on the web of the I-beam. The section gradually reduces, until it consists of only a web plate and two angles at the top.

Field Connections; Insulated Legs

Principally with the idea of facilitating erection, the specifications allowed the bolting of all field connections, provided the members were assembled and reamed in the shop. The punching of holes not over $\frac{1}{16}$ in. was permitted, the reamed hole to be $\frac{13}{16}$ in. $+ \frac{1}{64} = 0.8281$ in. The use of turned bolts not less than $\frac{13}{64} + \frac{1}{64}$ in. — 0.02 in. in diameter was required for use in case of field bolting. In places where the connections when erected in the field did not comply with the requirements to allow bolting, the contractor was required to use rivets.

The original design of the bases of tower legs did not contemplate the use of any insulating material between the steel bases and the foundations. Provision for an effective spark gap of not less than 10 in. had to be made later when the Navy Department decided that the towers should be entirely insulated from the earth. This meant the taking care of a downward thrust of 750,000 lb., and upon reversal of stresses an uplift of 400,000 lb. All forces acting at the base of the leg would have to be taken care of by interposing between the steelwork of the tower legs and the steelwork of the foundation anchorage some durable material of high insulating properties, combined with high strength in compression.

Glass and porcelain appeared first as the most desirable insulating materials, but no manufacturer could be found in the United States who had successfully made glass insulators of the size and strength required for this work. The only place where glass insulation of this character was being used was at the large radio station at Tuckerton, N. J., where a single steel mast of German manufacture was being erected by a private company. The glass insulators for these towers were made especially for them in Germany.

A design was then prepared for a porcelain built-up insulator, and two large manufacturers of porcelain insulators for high-tension line work made proposals for their manufacture. The insulators are clearly shown in

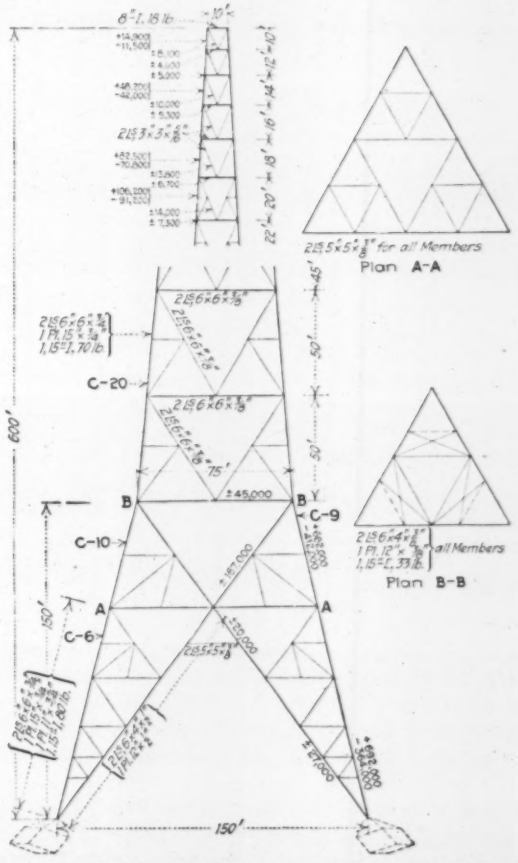


FIG. 4. GENERAL DESIGN OF TOWERS, WITH SOME STRESS FIGURES

the view taken at the base of one tower leg. Each one is built up and cemented together at the factory. Three porcelain disks of petticoat form are placed in the center with a malleable-iron casting at the top and bottom. The whole is thoroughly cemented together with neat portland cement, and the top and bottom faces of the casting are machined. The insulators are 10½ in. high, 10 in. in diameter at the top, 11 in. in diameter at the bottom bearing and 14 in. in diameter over the petticoats. These insulators are believed to be carrying the heaviest loads ever carried on porcelain insulators.

During their manufacture insulators were selected at random from the entire lot and tested for dielectric strength and for crushing strength. They showed very uniform results, standing a difference of potential of

The towers were erected on hardwood blocking arranged with wedges for releasing the load on the blocking and bringing it upon the insulators. The contractor used a wooden tower for the first 150 ft., on which were mounted booms of sufficient length to set the steel leg members. Above the 150-ft. level a long mast was used, the lower end being held by lines leading to the three legs. The middle point in each horizontal strut was shored by a wooden post stepped on the member below. The erection details were fully presented in *Engineering News*, June 24, 1915.

No serious accident to the personnel occurred during the erection of the towers. On the morning of Oct. 23, 1914, while the erecting force was raising column C-18 on leg C of tower No. 2, the brake failed to control the

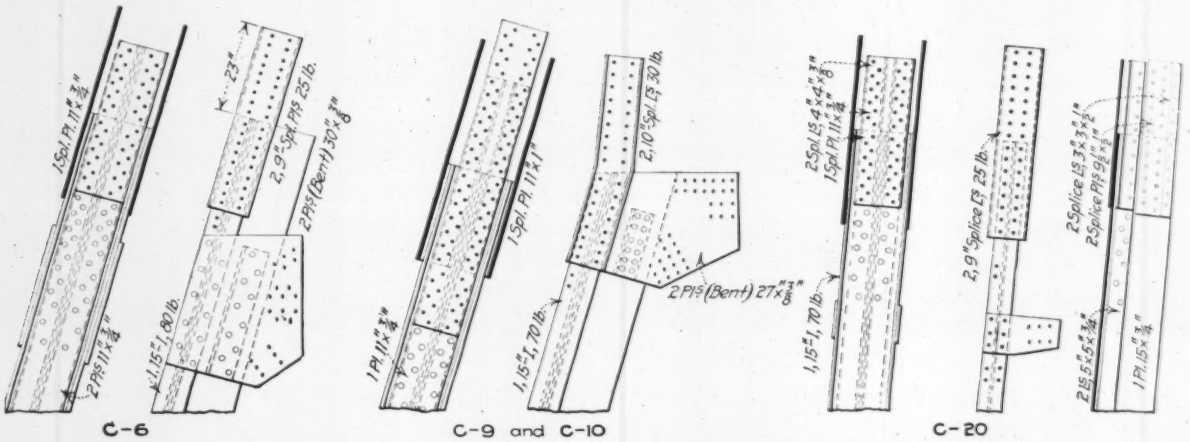


FIG. 5. DETAILS OF THREE OF THE COLUMNS OF THE DARIEN TOWERS

110,000 volts when dry and a wet test of 40,000 volts with insulators inverted, filled with water and subjected to a spray, without flashing over on either test.

The compression tests were made by the Pittsburgh laboratory of the Bureau of Standards. The following is quoted from the bureau's report on a test of six insulators:

> Occasional sounds were noticed commencing in the vicinity of 400,000 lb.; these increased in number between 500,000 lb. and 600,000 lb. At 600,000 lb. (the capacity of the testing machine) the specimens were all intact except for a few radial cracks, extending from the rim toward the center, quite similar to a "craze," but occurring singly. Later, in handling sample No. 1, a piece fell out. It is demonstrated from the tests that the pieces are capable of carrying a load of 600,000 lb. for a short period of time without noticeable signs of fracture, except for a few hair cracks.

The insulators—180 in number—were manufactured by the Pittsburgh High Voltage Insulator Co.

Foundations and Steel Erection

Mass-concrete foundations are used, the weight of each footing being sufficient to overcome the uplift of the leg under the maximum combination of wind and antenna loads. The topography of the site made it a difficult matter to obtain favorable conditions for the footings, so that the thrust of the tower legs would not be liable to cause slides. The top of each foundation is finished in a plane surface normal to the center line of the main column of each leg. The Panama Canal Commission constructed the foundations and installed the insulators under the tower legs by its own forces. The foundation work was described in *Engineering News*, June 17, 1915.

drum that raised and lowered the boom with the result that the boom and load fell. The column, falling end on from a height of about 500 ft., embedded itself over 10 ft. in the ground. The boom fell across horizontal struts 10 and 11 at the 150-ft. level and snapped clean off in two pieces. The boom struck within a few feet of two men

Painting the Steelwork

In the shop the steelwork was painted with one coat of red lead, mixed as follows: 100 lb. red lead, 20 lb. white zinc, 5 gal. raw linseed oil, 3¾ pt. Turp. Japan drier.

After erection, all imperfect paint surfaces were cleaned down and gone over again with one coat of red lead of the same composition as the shop coat. Two field coats were applied, the paint being manufactured in accordance with the following Government forumulas: First coat—red lead (Pb_3O_4), 98% pure, 25%; graphite, 45%; medium chrome yellow, 15%; asbestine and silica, 15%. Second coat—graphite, 50%; medium chrome yellow, 25%; zinc chromate, 5%; prussian blue, 5%; asbestine and silica, 15%.

The great size and weight of the antenna made it necessary to provide power hoists for raising and lowering it. A 12-hp. motor hoist was installed on a platform inside one leg of each tower about 40 ft. above ground. By so doing, the hoist was insulated from the earth by reason of the tower insulation, and the necessity of a separate insulated foundation for each hoist was obviated.

Acceptance tests of the radio apparatus were conducted for a period of more than 30 days and demonstrated the station to be fully equal to all the contract requirements. Since its completion it maintains regular communication in the daytime as well as at night with the Arlington station. Therefore the success of the chain of high-powered stations is already assured.

The entire station was built to meet the requirements of the Bureau of Steam Engineering of the Navy Department, this bureau having cognizance of all radio work in the navy. The designing of the towers, buildings, etc., was done by the Bureau of Yards and Docks. The foundations for the towers, the buildings, water-supply, sewer system, power supply and auxiliary works were constructed by day labor employed by the Panama Canal Commission under the immediate supervision of the officers of the Corps of Civil Engineers, United States Navy, which is connected with it. The steel towers were built under a contract with the Penn Bridge Co., of Beaver Falls, Penn. The power-house machinery and radio apparatus were furnished and installed by the Federal Telegraph Co., of San Francisco, Calif.

Regulation of Excavations in Streets of Houston, Tex.

Some provisions of the city ordinance regulating and governing cuts and excavations in public streets in Houston, Tex., seem rather drastic at first; but the city has recently invested nearly $3,000,000 in new pavements, and it intends to protect them to the best of its ability. Houston has a commission-plan government. The city engineer is E. E. Sands. There are 23 sections to the ordinance. A few of the more important provisions are given in substance:

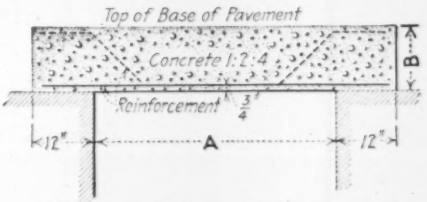
Any person, firm or corporation desiring to make a cut in a street must first file a written application for a permit. This application must contain a detailed description of what is to be done and, except in certain instances, must be accompanied by a plat showing the location of the proposed cuts. Plats are not required for service connections or for excavations for locating trouble in pipes already laid. The applicant for a permit must deposit, as cash or certified check, a sum double the estimated cost of the work.

In streets which have not been graveled, macadamized or paved the trenches may be refilled with moist, damp earth or by means of water-tamping, as the city engineer may direct. When water-tamping is used, the water is turned into the trench after the first 12 in. of backfill has been placed; and then the trench is kept flooded until the remainder of the backfill is put in. When the surface of the ground has been reached, the materials are allowed to settle, the trench is flooded again, refilled to the surface of the ground and again allowed to settle. After this settlement the trench is filled to an elevation slightly above the level of the street. All longitudinal trenches of more than 100 ft. in length must be rolled with a steam roller weighing not less than 6 tons.

On streets that have been macadamized, graveled or shelled the surfacing material must be first removed and kept separate from all other materials. The trench is backfilled as provided for in unpaved streets, but the backfilling must cease at 3 in. below the surface of the street. The macadam, gravel or other material is then replaced and thoroughly tamped and rolled and left at an elevation 2 in. above the remainder of the street. The same provision governs rolling as in the previous case.

If the street has been paved with brick, wood block, asphalt or other pavement requiring a substantial foundation, the trench must be refilled with well-rammed gravel, broken stone or brick-bats, concrete or other material that, in the opinion of the city engineer, can be so placed that there will be no settlement; or the trench may be refilled with earth in the same manner as described for unpaved streets and then covered with a reinforced-concrete slab (see accompanying illustration) at the option and discretion of the city engineer. If thought desirable, the city may do this part of the work and deduct the cost from the deposit on file with the city treasurer.

Another section of interest is that which makes it the duty of every person, firm or corporation owning, using, controlling or having an interest in pipes, conduits, ducts or tunnels under any public highway for any purpose whatsoever to file with the city within 90 days after the passage of the ordinance a map or set of maps on a scale of 200 ft. = 1 in., on tracing cloth, 15x23 in., showing in detail the exact location, size, description, date of installation (if known) of all mains, laterals, services and service pipes and of all valves, pressure regulators, drips, manholes, handholes, transformer chambers or other appliances. It is also made the duty of all persons or corporations having such subsurface structures to file within 15 days after the first of January each year a corrected map or set of maps, on a scale of not less than 200 ft. = 1 in., showing the complete installation of all such pipes and appliances, including all installations of the previous year. Whenever any pipe, conduit, etc., is abandoned, the city engineer must be notified in writing, and the abandoned line must be designated on the file maps for that year.



A	B	Reinforcement	Note
2'	10½"	½" ☐ Tw. Bars, 8" C. to C.	Alternate Bars bent up
3'	12"	½" ☐ " " 7" "	
4'	13"	½" ☐ " " 6½" "	
5'	14"	⅝" ☐ " " 9" "	
6'	15"	⅝" ☐ " " 8½" "	

REINFORCED-CONCRETE SLAB USED OVER BACKFILLED TRENCHES, HOUSTON, TEX.

These provisions, of course, do not apply to the city departments, which, however, are expected to live up to them. The penalty for violation of the ordinance or any section of it is a fine of from $10 to $200, and every day in which the ordinance is violated is deemed a separate offense. Before any permit is granted, the following fees must be paid the city engineer: $1.50 for trenches less than 50 ft. long, $3 for trenches 50 to 100 ft. long, $5 for trenches 100 to 500 ft. long and $10 for each 1,000 ft. for trenches over 500 ft. long.

Illinois River Flood

By L. K. Sherman*

The upper Illinois River Valley recently experienced one of the highest floods on record. On Jan. 22, following a long period of cold weather with temperature down to zero, there was a rise to 45°, accompanied by a general rainfall throughout the drainage area amounting to 2 in. or more during a 24-hr. period. Owing to the frozen, impervious surface and the accumulated snow, there was a high rate of runoff. Ice jams were formed at Copperas Creek, Henry and Ottawa. At Ottawa the ice above the Main St. bridge raised the water level 2 ft., flooding the armory and the new high-school building. The Spring Valley bridge was lifted off its bearings.

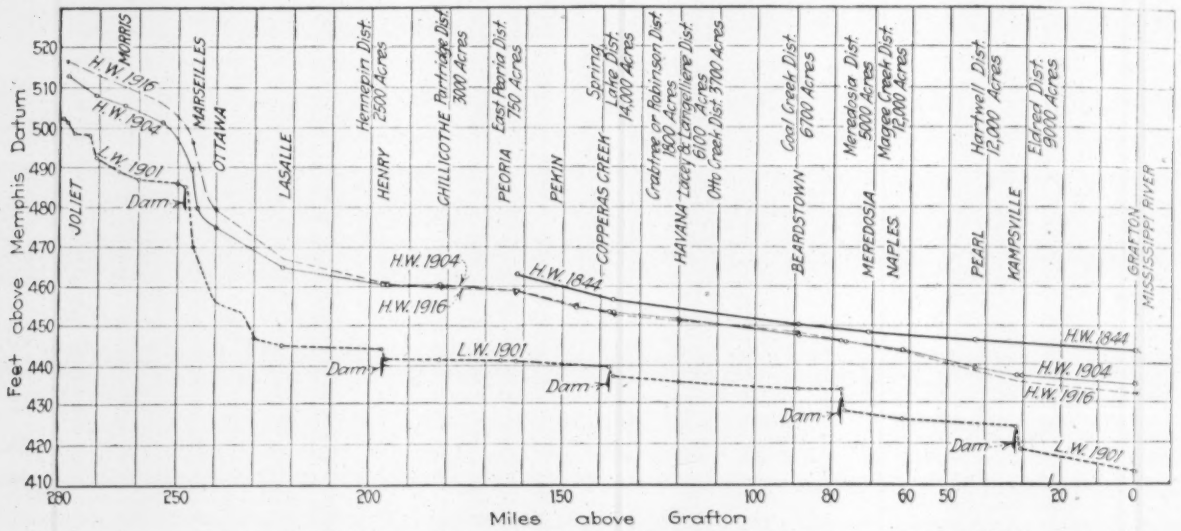
Since 1908 the flood plane of the Illinois River has been reduced 40% by the construction of drainage and levee districts, embracing 172,000 acres. In order to observe the flood effects upon these districts the Illinois Rivers and Lakes Commission assigned F. B. Foote, junior engineer, to the lower Illinois Valley during the high-water period. The Government forecast of a 26-ft. stage of water led the drainage districts to patrol and protect their levees.

The East Peoria levee district was seriously threatened. At the lower end, where the drainage ditch to the pumping station runs close to the levee, the embankment had settled about 2 ft., but vigorous work with sand bags prevented a break. This levee, in general, stood about 3 ft. above high water. Strenuous and effective work was done in protecting the Spring Lake drainage district, of 13,600 acres, between Pekin and Havana. At several points crevasses started. The contractor for the marine railway that is to transport boats over the levee, together with a large force of men belonging to the drainage district, worked continuously during the peak of the flood in placing sand-bag revetment and strengthening the levee, so that very little flooding occurred.

In this same territory the Crabtree levee broke before the flood reached a high stage. The Otter Creek and Spoon River districts were partly flooded from bluff waters.

The Lacy and Langellier districts were carefully patrolled, and sand-bags were collected; but their levees stood up well. The West Matanzas levees were not completed at the ends, and the territory was flooded. Little damage was done, however, as the inclosed land has not yet been reclaimed. Water was kept out until the river reached a 16-ft. stage. Sand-bag dikes were built to prevent the overflow water from cutting out the gaps in the levee.

The Meredosia, McGee Creek, Hartwell and Eldred districts were flooded, the last case being due to uncompleted repairs. The Hartwell levee failed, owing to seepage where the outlet pipe of a former pumping station had been removed. This could not be stopped, and a crevasse of 150 ft. occurred. The levee at Naples, built by the Illinois Rivers and Lakes Commission in 1914, held perfectly and could have safely stood an additional rise of 3 ft. On the upper river the Partridge district levee, opposite Chillicothe, was partly washed out by wave action. The Hennepin district, of 2,500 acres, planted in winter wheat, was flooded and the crop destroyed.



PROFILE SHOWING FLOOD AND LOW-WATER LEVELS IN THE ILLINOIS RIVER

The flood of 1904, which at most places was the greatest flood of recent years, reached the rate of about 80,000 cu.ft. per sec. at Peoria. The flood height of January, 1916, was greater than that of 1904 above Peoria; but lower, downstream. The Mississippi River stood 4.6 ft.

Most of the completed levees built under adequate engineering design were perfectly safe during the past flood. It is the general practice in the Illinois Valley to locate the levees 50 or 100 ft. from the normal shore line, leaving a strip of timbered land as a protection from current and waves. Most of the levees are built by floating dredges, and little attempt is made for finish, except to provide that no part is below the specified grade. The reclamation of overflowed lands by levees and pumping has passed any experimental stage in the Illinois Valley, and the drainage districts include some of the most productive and valuable land in the state, as well as being the most reliable in the uniform production of crops during periods of either flood or drought.

*Member of the Illinois Rivers and Lakes Commission, Chicago, Ill.

lower than during the flood of 1904, when the peak passed Beardstown. Had the Mississippi stood at the 1904 or the 1844 stage, the January, 1916, flood would have been materially greater as far as Beardstown.

The elevation of the highest water of the flood of 1904 and that of January, 1916, are shown on the accompanying profile. The crest of the 1916 flood moved down the river as shown in the table herewith, which gives the time at which the highest water stood at the various points.

TRAVEL OF CREST OF 1916 FLOOD IN THE ILLINOIS RIVER

Miles Above Mouth	Place	Time of Maximum Flood Height	Maximum Flood Elevation, Ft.
265	Morris	11 p.m., Jan. 21	510.42
240	Ottawa	8 a.m., Jan. 22	479.01
223	La Salle	7 p.m., Jan. 22	467.36
196	Henry	6 a.m., Jan. 24	460.89
165	Peoria	7 a.m., Jan. 25	458.92
140	Copperas Creek	6 p.m., Jan. 30	452.75
90	Beardstown	7 a.m., Feb. 1	447.95
90	Beardstown	Feb. 4	447.55
0	Grafton	7 a.m., Jan. 31	434.56
0	Grafton	p.m., Feb. 4	430.00

Owing to the extent of reclamation of the flood plane of the Illinois by the drainage districts and the possible effects upon flood heights, the fish industry and the extensive agricultural interests, the State Rivers and Lakes Commission has had a comprehensive investigation and report made by Alvord & Burdick, consulting engineers. This report is in press. Among its findings are the following:

The average flood expectancy, about once in 50 yr., is a flood about 35% greater than the flood of 1904. Levees should be designed for such flood stage.

The net effect of levee districts now constructed is to increase the maximum flow rate 5%, and when the bottom lands are fully leveed, 10%. Where levees are built upon both sides of the river above the junction of the Sangamon, the distance from center to center of levees should be not less than 1,200 ft., and where reasonably possible 2,000 ft. Below the Sangamon the land is nearly all leveed. The available cross-section for flood waters can be most economically enlarged by increasing the height of the levees.

The Illinois Rivers and Lakes Commission assists projects for drainage and reclamation, so far as may be, by furnishing engineering data or advice. It is the duty of the commission to see that no public streams are encroached upon and that tributary public lakes, useful for flood storage, navigation or fish breeding, are not seized by private interests.

Check Dams in the Mountains of Los Angeles County

By Frank H. Olmsted*

[In *Engineering News* of Feb. 17, Mr. Olmsted described the experimental check dams built under his direction in the summer of 1914 on the mountain torrents back of Los Angeles, to determine the possibilities in flood control, which are being studied by the Los Angeles County Flood Commission. These check dams were built on Haines Cañon, a stream with about 4 sq.mi. drainage area, which in the great flood of 1914 had a maximum discharge estimated at over 2,300 sec.-ft. Concerning the flow from this stream since its regulation by check dams in the storm of Jan. 17, 1916, Mr. Olmsted has written as follows.—Editor.]

There is no indication that this year the flood from Haines Cañon reached at any time over 25 cu.ft. per sec. The storm of January was much less severe than that of February, 1914, yet it rained almost every day in January; and from 11 a.m., Jan. 16, until noon, the Government gage in Western Empire Cañon, a small tributary of Haines Cañon, showed 5.7 in. of rainfall. I, myself, was in Haines Cañon from 11 a.m., Jan. 17, to 3 or 4 p.m., and the highest water had passed from a sharp precipitation occurring about 6 a.m. At 11 a.m., Jan. 17, where the Haines Cañon wash crosses Cedar, the channel was dry, with no water running, although there were evidences that 20 to 25 sec.-ft. of water might have passed at the mouth of the cañon. At 3 p.m. the stream measured 5 cu.ft. per sec. There was no time during January when there was not a stream of at least 3 to 4 cu.ft. per sec. coming out of Haines Cañon; but out of Western Empire Cañon, which had been treated quite thoroughly with check dams two years previously, not a single drop of surface runoff over the cone at the mouth of the cañon where it enters Haines Creek had taken place. There is no doubt that there was a stream under the boulders more or less slowly flowing into Haines Creek. There was certainly no surface storage back of these check dams to account for the absence of any runoff in the bottom of the cañon.

Western Empire Cañon drains an area of 22 acres and has six check dams that cost a total of $200. Its channel, up to the time of the construction of the dams, had been as dry and barren as any desert. There was not a vestige of moisture, except during storms. All last summer, however, there was a small trickling stream in this cañon, and willows and other vegetation were growing rapidly all the way down the cañon.

This winter's test has only strengthened our opinion that the retardation of these torrential flood flows will result in a perennial stream flow where the cañons are properly obstructed by check dams. The ground of these cañons has a greater absorption capacity for water than any of us had hitherto believed possible.

It may be thought strange that there is no runoff from the mouths of these cañons. The explanation is that the water during flood periods ordinarily carried a large amount of silt and slime, which rendered the floor of the cañon almost impervious, so that the water flowed on the surface. When the velocity of the flow is broken by the check dams, there is no erosion of the silt; the water that flows is clear and rapidly sinks into the gravel beneath the stream bottom.

On my last trip into Haines Cañon I noticed a spring of water breaking out in the trail, which has always been dry before, 30 ft. above the bed of the creek. The check dams above had forced the water into the porous soil and the lines of cleavage in the rock, and this water was coming out along the line of least resistance on a dry trail 30 ft. above the creek bed.

*Consulting Engineer, Los Angeles, Calif.

Fees for Surveys of Cache Drainage District of Craighead County, Arkansas, to the amount of $15,652, have been declared noncollectible by the Arkansas Supreme Court on the ground that the district was not legally formed. The act designed to create the district was passed in 1911, and the district was abolished by the legislature in 1913. The Morgan Engineering Co., Memphis, Tenn., was appointed engineer of the district and made extensive surveys. The county refused to pay the warrants of the company on the ground that the act creating the district was void because of an insufficient description of boundaries. Both the Circuit Court and the State Supreme Court held that the contract between the company and the board was void, since the district itself was void.

Long Log and Block Conveyor at Hinckley Dam

By S. Reswick*

The Hinckley Fiber Co., of Hinckley, N. Y., a concern that manufactures pulp for paper, has just completed the construction of a conveyor about 2,000 ft. long on the shore of West Canada Creek in the village of Hinckley, N. Y. This conveyor is to transport logs from the reservoir, formed by a recently completed dam, to the mills located about 2,000 ft. below.

West Canada Creek here is about 500 ft. wide. On account of its location and altitude the New York State Barge Canal utilized the river to feed the new canal at its summit level near Rome, N. Y. For that purpose a masonry dam was constructed at Hinckley, and this created a storage reservoir. The difference of water level at the down side of the dam and the upstream side is 65 ft., or from El. 1,160 to 1,225, and the earth dikes leading to the main dam are 15 ft. higher. It is expected that the water level on the upstream side of the dam will fluctuate between El. 1,190 and 1,230, on account of the necessity of supplying the water to the mills located downstream and also to feed the canal in working season.

Before the dam was built, the Fiber company, in getting its wood supply from timber lands in the Adirondacks, used to float the lumber downstream directly to the mills. After the dam was completed, the logs could not reach the mills by water, and the company built this conveyor for their transportation. The conveyor machinery is mostly of standard type; the unique feature is the inclined section. It lifts the logs directly from the water and carries them to a saw-mill located on top of the slope, from where the blocks are taken to the pulp mills by the horizontal part of the conveyor.

The incline is 150 ft. long and has a slope of 20°. It consists of two parts—one stationary and resting upon concrete piers, the other part movable. The movable part consists of two sections, each 35 ft. long, connected together by hinges. One end of the detached sections is attached to the stationary part, and the other end is suspended on chains from a platform. By machinery and gears it can be raised or lowered according to the fluctuation of water level in the reservoir.

Fig. 1 shows the platform upon which is installed the operating machinery by which the suspended part of the conveyor is regulated. It rests on four rectangular reinforced-concrete piers which, at the present stage of the water level, are submerged under water more than half of their height. The conveyor proper (see Fig. 2) consists of a timber framework and deck supported on concrete piers and carrying three roller log-haul chains and the necessary sprockets, shafting and driving gear; it is driven by a 35-hp. electric motor located in the starter house. The chains run about 86 ft. per min. and deliver 19 logs (from 13 to 20 ft. long) per minute.

Another feature in this construction that is worth noticing is the saw-mill, or as it is called, the slasher house. It stands on top of the slope, as can be seen in Fig. 1. It is a one-story structure with basement. The basement walls are of reinforced concrete; the story above is a wood frame with the necessary openings for belting and the admission of long logs.

All the machinery, as motors, generators, gearing wheels, is installed in the basement, while on the floor above is a gang system of circular saws operated by belting running through the flow from below.

*Assistant Engineer, New York State Barge Canal, Hinckley, N. Y.

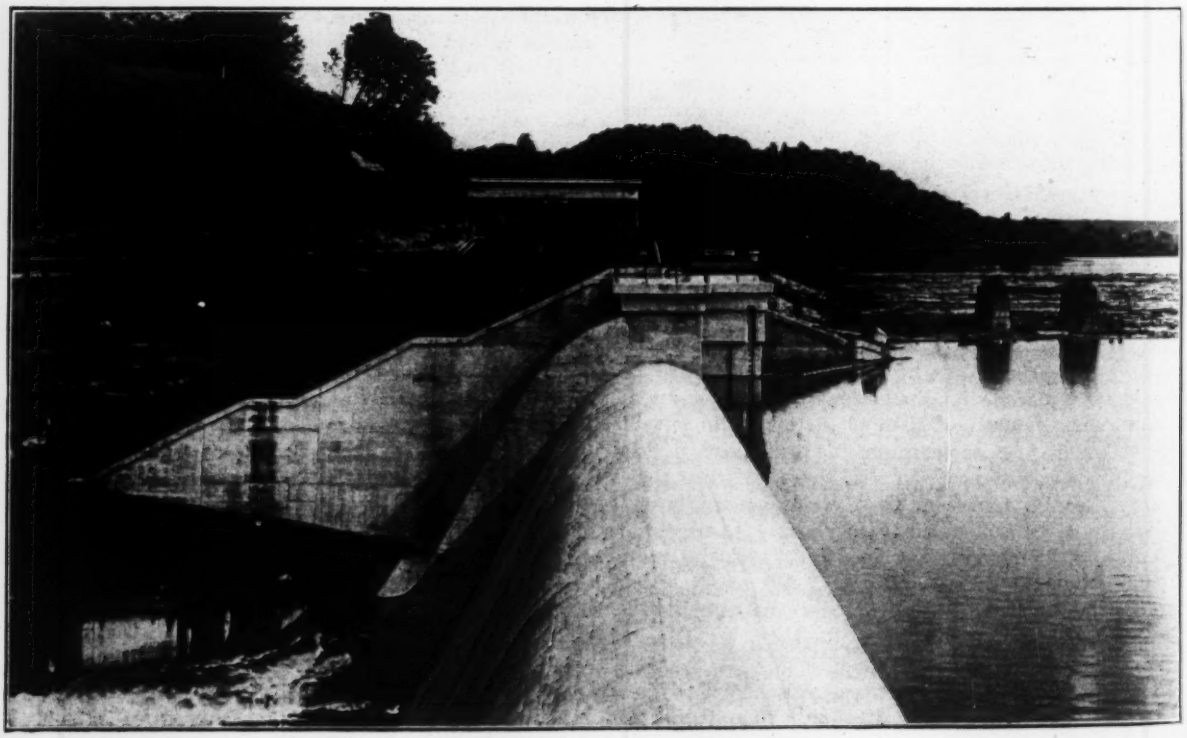


FIG. 1. LOG AND BLOCK CONVEYOR OVER HINCKLEY DAM

As the logs reach the top of the floor, they roll over to a platform, where they are caught on slasher chains and sprockets and carried to six circular saws spaced 2 ft. apart. After passing the saws, the cut-up logs roll out to a short trough conveyor placed perpendicular to the line of the saws. By this they are carried to the

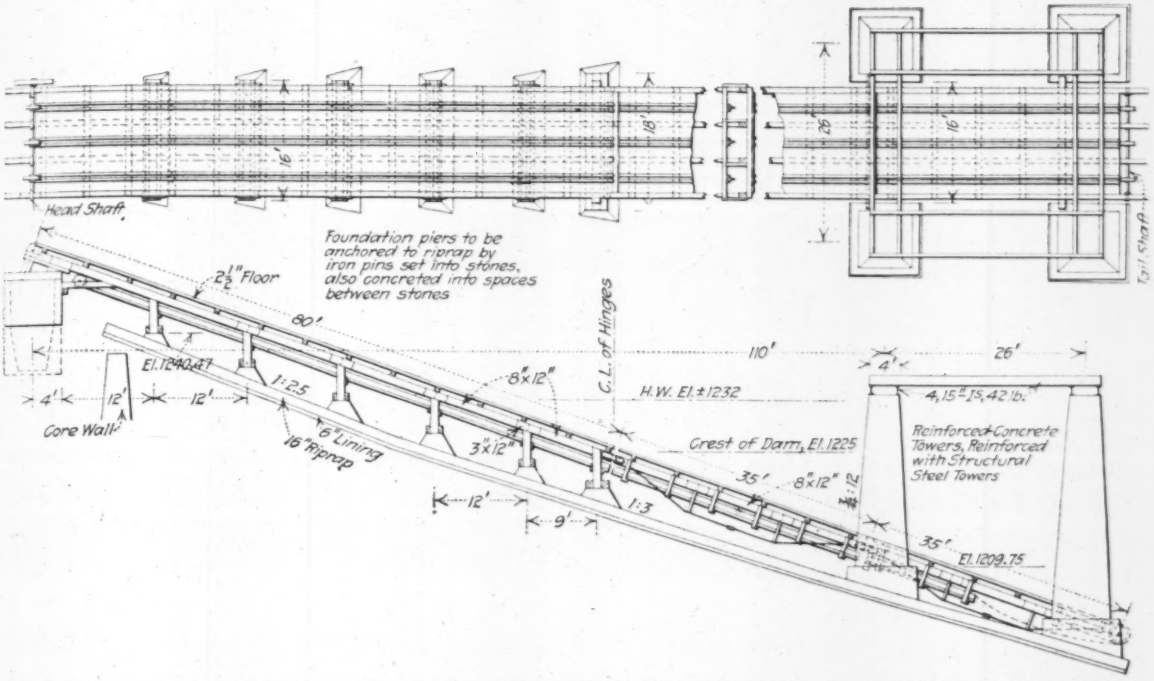


FIG. 2. MOVABLE INCLINED SECTION OF LOG CONVEYOR AT HINCKLEY DAM FOR NEW YORK BARGE CANAL

long, fixed conveyor. This last consists of a large carrying trough and a small return trough with a walk between, all supported by a pole trestle on concrete piers. The fixed conveyor is nearly 1,800 ft. long and is divided into two parts. Each part is fitted up with an endless chain to which are attached suitable flights to carry the wood. It is driven through a double set of gears by a 50-hp. motor in the slasher house.

The capacity of the whole plant is from 250,000 to 300,000 ft. of lumber—taken from the water, sawed up and delivered to the mills in a 12-hr. day. The force required to operate it, besides the machinist and steam engineer, is only eight laborers—two at the water's edge, two in the slasher house, one on the cable conveyor, two at the end of the conveyor and one at the levers.

The plant was constructed by the Hinckley Fiber Co., and the engineer in charge of the construction was C. G. Clinch.

Progress of Chinese Railways*

Europe and America and Japan are training thousands of Chinese engineers and experts. The United States alone is educating today 1,100 Chinese students in engineering, mining, agriculture and other scientific and technical branches. What is most needed in China is capital. Where money is adequately provided, trained men can be found to do the work and do it cheaply and efficiently.

The Peking-Kalgan Ry., a line of 143 mi., which was in the opinion of foreign experts, the most serious and difficult engineering proposition ever undertaken in China, with its steep grades, sharp curves, heavy cuts and fills and more than a mile of tunnels, was built entirely by Chinese engineers educated in the United States.

The successful completion of this line was all the more significant, because there were not a few foreign engineers who had thought this piece of engineering was an impossible feat. In spite of all these difficulties the cost of construction was under $50,000 per mile, a rate much lower than that on the roads built by foreign engineers in the less difficult regions of the country.

It now brings a net revenue approximately of $1,000 gold per mile annually to the Chinese Government, and this surplus is being used to build extensions, 90 mi. having just been completed.

The Chinese street railway of Shanghai was built and is operated by Chinese. The biggest ironworks in China are managed by Chinese engineers educated in Europe. If further evidence is required, one can point to the big cities in the Straits Settlements, where many of the big business enterprises, such as mining and steamship companies, sugar plantations and banks, have been built up by Chinese energy with astonishing success.

Of the total mileage of railways (6,200) now in operation in China, about 80% was financed by foreign bankers and built with the direct coöperation of the Chinese engineers. With the exception of a few short local lines, they are all making money. The Peking-Mukden Ry., a line of 605 mi., brings approximately a net profit of $6,565 gold per mile per year to the Government, while the Peking-Nankow Ry., 836 mi. long, yields a net revenue of $14,500 per mile per annum.

*From an address by Dr. U. K. Wellington Koo, Chinese Minister to the United States, before the Chamber of Commerce of the United States.